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OPERATIVE SURGERY

ON THE DEAD BODY.

LONDON

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A MANUAL
OF
OPERATIVE SURGERY
ON THE DEAD BODY.

BY THOMAS SMITH, F.R.C.S.


DEMONSTRATOR OF ANATOMY AND OPERATIVE SURGERY AT ST. BARTHOLOMEW'S HOSPITAL:
SURGEON TO THE GREAT NORTHERN HOSPITAL.

WITH ILLUSTRATIONS.

LONDON:
LONGMAN, GREEN, LONGMAN, AND ROBERTS.

1859.

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P R E F A C E.

THE requirements of the medical examining boards of this country seem to imply that a practical knowledge of operative surgery should form an essential part of the education of every surgeon, and that henceforth operative dexterity should be acquired by practice on the dead body.

For this reason, the performance of surgical operations on the subject has been introduced at most of our medical schools ; and demonstrators have been appointed to superintend and direct the studies of gentlemen in that department.

The design of the present Manual is to give to students a practical guide to the performance of operations on the dead body, and to lighten the labours of teachers, by enabling them to dispense with much oral instruction, and to substitute the same kind of supervision that is ordinarily exercised in the study of practical anatomy.

Only those operative measures are here treated of, which can be advantageously practised on the dead body ; and these are arranged, as far as possible, in the order in which

they should be performed,—an order rendered necessary in this country by the scarcity of anatomical subjects.

The Woodcuts which are here and there introduced in the following pages were, with one or two exceptions, traced from photographs taken from the dead body, during the actual performance of the operations which they represent.

For the original photographs, as well as for their reproduction upon wood, the author is indebted to the artistic skill of Mr. Godart.

Bedford Row, August 31st, 1859.

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A MANUAL

OF

OPERATIVE SURGERY

ETC. ETC.

CHAPTER I.

INTRODUCTION.

The Selection of a Subject. — Instruments. — Assistant. — A Table of Operations.

It rarely happens that the student of operative surgery in this country has a choice of bodies for his purpose; to those who have such an opportunity, we would recommend the selection of a male subject with a moderate amount of fat about it. An emaciated body gives too low an idea of the difficulties of ligaturing arteries on the living; while its deficiency of subcutaneous tissue renders it difficult to provide sufficient material for the formation of stumps in the practice of amputations. The subject should be placed on a high and narrow table, such as dissecting-rooms are generally furnished with.

To save subsequent trouble, the operator should at once provide himself with those instruments which will suffice for the performance of all the ordinary operations: these instruments, with others, are contained in the regulation

cases supplied to surgeons in Her Majesty's service; an old case of this description will be found most serviceable, as in it the knives will have been worn down by successive sharpenings; generally speaking, their blades are originally too wide for some of the more difficult amputations. The services of an assistant should be procured if possible; and we venture here to remind those who may officiate in that capacity, that there is much to be learnt of the important duties of their post from operations even on the dead body.

For the use of those who have but one subject at their disposal, we append a table of operations that may all be practised on a single body. This list, which can be modified at the discretion of the operator, will be found to contain most of the operations in common use on the living, and may serve to guide some in the economical use of their material.

Table of Operations that can be performed upon one body, arranged in the order in which they should be practised.

Incisions and sutures. Plugging the nares. Catheterism of Eustachian tube and lacrymal duct. Mr. Bowman's operation on the punctum and lacrymal duct. Operations for strabismus. Excision of eyeballs. Tenotomy. Division of sterno mastoid, tibialis anticus, hamstring tendons, tibialis posticus, tendo Achillis. Artificial anus. Ligature of all the arteries. Trephining. Tracheotomy. Laryngotomy. Pharyngotomy. Lithotomy.

AMPUTATIONS.

<i>Right side.</i>	<i>Left side.</i>
Distal phalanges of fingers and thumb.	Phalanges at all their articulations.
Fingers, <i>en masse</i> , at metacarpal joint.	Hand at carpal articulation, leaving the thumb.
Hand at wrist joint.	

On both sides.

Amputation at lower and upper third of forearm. Excision of elbow joints.
 Amputation of upper arm at lower and middle thirds.
 Resection of the shoulder joint. | Amputation at the shoulder joint.
 Amputation of the breasts.

Right side.

Resection of the upper maxilla.
 Amputation of the toes *en masse*
 at metacarpal articulations.
 Chopart's amputation.
 Pirogoff's ditto.

Left side.

Resection of half the lower maxilla.
 Amputation of phalanges at their various joints.
 Lisfrane's amputation.
 Syme's ditto.

Amputation of the legs in their middle and upper thirds. Resection of both knee joints. Amputation of the thighs in their lower thirds.

Amputation at upper third of the thigh.		Amputation at the hip joint.
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Amputation of the penis.

We would here, once for all state, that throughout the following pages, wherever distances on the body are expressed by *inches*, it is presupposed that the subject is an adult, and of average size and proportions. Again, whenever the expressions *left-hand side* or *right-hand side* are employed, they always refer to the left, or right-hand side of the body which is being operated upon.

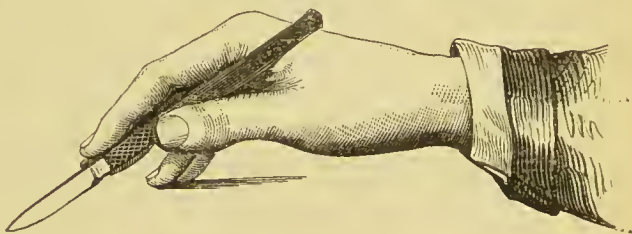
CHAP. II.

SOME OPERATIONS IN MINOR SURGERY.

Methods of holding the Knife.—Sutures.—Plugging the Nostrils.—Catheterisation of Eustachian Tube and Lacrymal Duct.—Mr. Bowman's Operation on the Lacrymal Punctum.—Removal of the Eyeball.—Artificial Anus.

THE positions in which the knife is held in operative surgery necessarily vary much; we shall, therefore, only attempt to describe some of the principal.

The first (fig. 1), where the scalpel is held as a pen in writing, is an easy, elegant way of holding the knife, and

Fig. 1.*Fig. 2.*

is adapted for any delicate dissection, and in wounds of inconsiderable extent, where the parts to be divided offer no great resistance. It is used chiefly in the ligature of arteries, in the removal of small tumours, and in nearly all small

operations. In figure 2, the knife is held as the bow of a violin; the position gives great freedom and a wide range of motion, though it requires greater dexterity than the former, as the hand cannot be steadied on the neighbouring parts. It is made use of in the removal of the breast, or

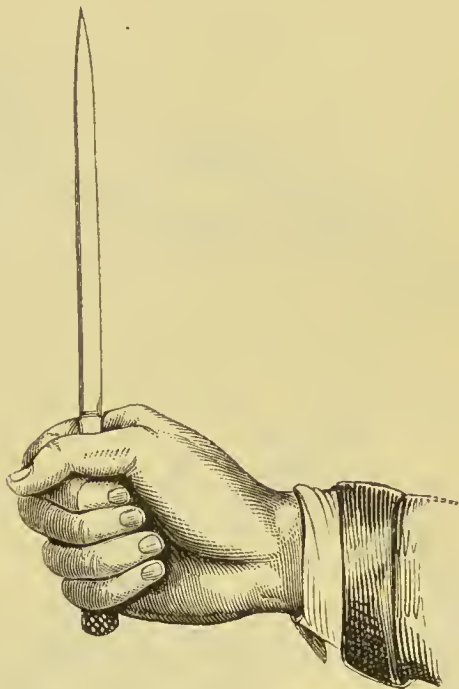
Fig. 3.*Fig. 4.*

in the excision of any tumour of large size. The knife may be grasped as an ordinary dinner knife, as seen in figure 3, a method well suited for amputations about the carpus and tarsus.

Figure 4 represents the manner in which the scalpel should be held in laying open fasciæ or aponeuroses, on the grooved director.

In figure 5, the knife, which in this case is always a large one, is held in the full grasp of the hand; it is thus used in circular amputations, and in certain other instances to which we shall hereafter have occasion to refer.

Fig. 5.



Sutures are of various kinds, and are generally classified as—(1) interrupted; (2) uninterrupted; (3) twisted; and (4) quilled. The above-named modifications owe their existence to the varying necessities of wounds, as the latter occur in one or another part of the body. Thus the (1) interrupted is used for wounds where absolute apposition of every portion of their surface is either undesirable or unnecessary; as in stumps after the removal of limbs; in the wounds left by the removal of tumours, or amputation of the breast.

(2.) The uninterrupted or continuous best secures the

accurate apposition of their edges, and is therefore used in wounds of the eyelid and intestines.

(3.) The twisted will retain in absolute contact the whole surface of a wound of considerable depth; it suits its purpose well in hare-lip, in wounds laying open the cavity of the mouth, or in extensive division of the abdominal walls.

(4.) The quilled suture is said to serve the same purpose as the former variety, though with less certainty and efficacy; it was formerly used on the perineum.

The *continuous*, or uninterrupted suture, consists in the simple sewing together of the edges of a wound, taking care that the needle penetrates the whole thickness of the skin at each stitch. The thread, to prevent it pulling through, should be knotted at its end before commencing, and the needle should be curved at its extremity.

In passing the *interrupted* suture, precisely the same method may be employed, except that after each complete passage of the needle through the wound, the thread should be divided, leaving an end on either side sufficiently long to be tied in a double knot. This knot should fall a little to one side of the line of contact between the edges of the wound.

In passing the needle in the two foregoing methods, if possible, the edges of the wound should be held in contact, with the forefinger and thumb of the left hand; or the edges of the wound may be put on the stretch, so as to bring them parallel with each other, that their opposite parts may exactly coincide.

If silver or iron wire be used, as is now the custom, instead of thread, it must be fastened by first crossing and then twisting the opposite ends of the suture together; it should not be cut off too near the wound, or on the living body it would be removed with difficulty.

To apply the *twisted suture*, hare-lip pins, silk, or twine, and the cutting wire pliers, are necessary.* The pins must be carefully passed in, about half an inch from one edge of the wound; they must traverse it, and appear at the same distance beyond its opposite margin.

When the requisite number of pins have been introduced, a piece of silk or twine, about two feet long, is taken and twisted over each in the form of the figure 8, so that the point of crossing of the thread lies over the line of contact of the edges of the wound. The thread may be secured by tying its opposite ends together, and the pin may be cut so as to leave about half an inch projecting at either end, beyond the thread.

The *quilled suture* is best applied with a strong curved needle, fixed in a handle, and having an eye near its point. This should be threaded with a double thread, and having been passed through the wound from side to side, the looped end of the ligature is detached from the needle's eye, and held with the left hand, while the needle is withdrawn.

The needle should pierce the skin an inch from the edge of the wound, should traverse the deep parts, and emerge at the same distance from its opposite margin. When withdrawn, there will be a double thread remaining in the wound having a loop at one extremity and two free ends at the opposite. Through the loop or loops, if more than one suture be used, a piece of gum catheter should be passed and the thread drawn tight over it, while the opposite ends are tied firmly over a similar piece of catheter.

To maintain perfect apposition in the more superficial

* This suture is best applied to the wound in the face, left after the removal of the upper jaw.

parts of the wound, it is necessary to add a few interrupted stitches at the intervals between the quilled sutures.

If it be thought desirable to practise the application of any of the foregoing methods, the front wall of the abdomen should be used for the purpose, where also*, the method of making incisions with the scalpel held in the first position may be practised.

Plugging the posterior nares. — This operation, sufficiently disagreeable on the living, is still more so on the dead body; yet we venture strongly to recommend its practice, for though it presents no particular difficulties to those who have once performed it satisfactorily, yet a first attempt to plug the posterior nares is less easy of execution for the operator and more irksome to the patient than might be supposed.

The subject being on its back, and the head slightly raised on a block, artificial means must be used to keep the jaws apart. The operator must provide himself with cotton wool or lint, some strong twine, a pair of forceps, and a bent catheter, or better still, Bellocq's cannula, the proper instrument for passing a ligature from the posterior nares into the mouth. A firm oblong plug should be made of cotton wool twisted together, about the size of the last joint of one's thumb; to this should be tied by its centre a piece of doubled twine two feet in length, so that there may be four ends attached to the cotton wool. One of these should be cut off closely, another left about six inches long, and two may remain as they were. The whole should now be smeared with oil. The instrument for passing a ligature into the pharynx being armed with a piece of twine, should be passed along the floor of the nostrils until it reaches the pharynx, when the watch spring being projected, it will appear in the mouth. The

* For this see the preliminary remarks on Ligature of the Arteries.

end of the string being held with the forceps, the instrument may be withdrawn and the string brought out of the mouth.

To this string attach the two longer strings of the plug, and pull at the nasal end of the string until the plug sticks

Fig. 6.



fast against the soft palate; introduce the forefinger of the left hand into the mouth, and push the plug backwards, at the same time gently pulling the end at the anterior nares. In this way the cotton wool may be adjusted to one of the posterior nares, the two strings which will be found hanging out at the anterior nostrils being separated, a piece of lint or wool should be stuffed in between them and they tied over it. This will fix the posterior plug, and entirely close one side of the cavity of the nostrils. The shorter piece of twine attached to the plug may either remain hanging out at the mouth, or, in a living patient, had best be swallowed and allowed to hang down into the pharynx; its use is to withdraw the apparatus when no longer needed; and this is effected by first cutting the knot at the anterior nostrils and taking out the anterior nasal plug, the posterior being withdrawn through the mouth by means of the aforesaid string.

If the operator be desirous of performing the catheterisation of the Eustachian tube and lacrymal duct, he should proceed at once to their execution.

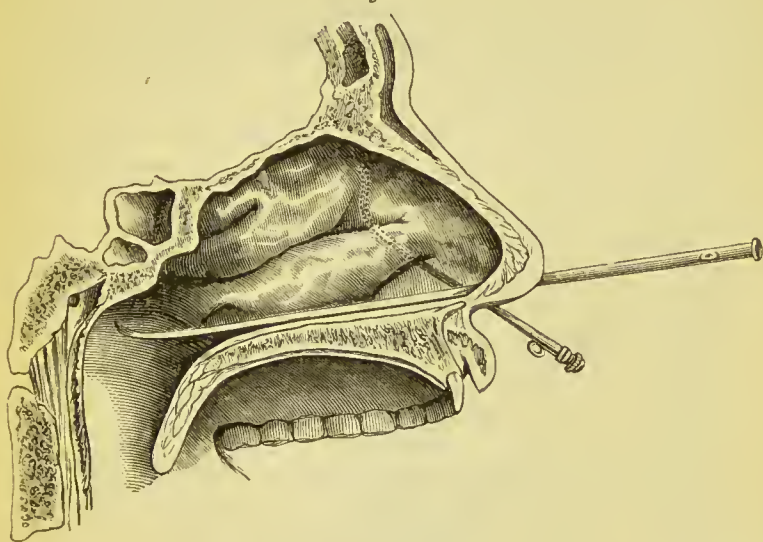
Passage of the Eustachian catheter. — The head of the subject being slightly raised, the operator should stand on its right-hand side; he should be provided

with a catheter similar to that represented in the adjoining woodcut (fig. 6). This we have found to possess the most suitable curve for the purpose.

Before commencing this operation, it may be well for the operator to reflect on the exact position of the pharyngeal orifice of the Eustachian tube. It is situated behind, and somewhat above and external to the posterior extremity of the inferior turbinate bone.

The catheter should be introduced into the nostrils with its convexity upwards, its point on the floor of the nares,

Fig 7.



and its handle directed downwards. The handle should be gradually elevated while the operator glides the point of the instrument along the floor of the nostrils until the pharynx is reached; this is ascertained by the sensation communicated to the hand, of the point of the catheter passing over the edge of the palate and falling into the pharynx. Having effected this, rotate the handle of the catheter between the finger and thumb, so that its point may pass from below upwards and outwards, until it meets

with an obstruction, which is generally felt after it has turned rather more than a quarter of a circle. On turning the handle more forcibly the point will be felt to slip over this, the lower margin of the cartilaginous extremity of the Eustachian tube. The catheter should now be pushed onwards, outwards, and upwards very gently, until the point is fairly in the cartilaginous extremity of the tube. Its arrival at its proper destination may be ascertained by rotation being now no longer possible, and by the ring (fig. 6 *a*) at the bottom of the catheter being directed towards the opposite angle of the mouth.

Fig. 8.



Figure 7 represents the catheter in position, and shows the position of the orifice of the Eustachian tube.

Catheterisation of the nasal duct from below.

—The lower orifice of the lacrymal duct may be found at the anterior extremity of the inferior turbinate bone, beneath its overhanging border on the outer wall of the inferior meatus of the nose (fig. 7).

This proceeding may be effected with such an instrument as is delineated in the adjoining woodcut, or a soft silver probe may be bent to the same shape (fig. 8).*

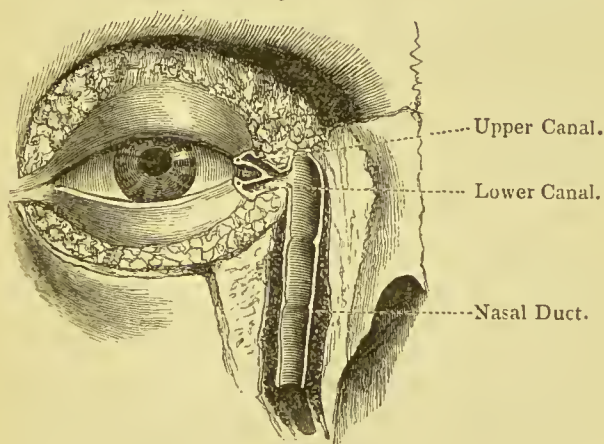
The head being in the same position as in the preceding operation, the catheter may be introduced with its concavity looking upwards, and its point directed to the lowest part of the outer wall of the nostril. Being in contact with the outer wall of the meatus, it should be gently passed upwards with a slight rotatory movement of its point, in an

* The instrument here figured is adapted for the duct of the right side.

upward and outward direction, until it is arrested by the under surface of the inferior turbinate bone. Glide the point gently along the under surface of this until the former is arrested by the opening of the duct at the anterior extremity of the bone. Now complete the rotatory movement of the probe, at the same time pushing it gently upwards, when it will be found to enter the duct, and if possessing a large curve, may be felt with the finger at the inner angle of the orbit.

The operation for opening the lacrymal duct through the cheek having been justly abandoned, as both unsightly and unsurgical, we shall proceed to describe Mr. Bowman's excellent practice of slitting up the lacrymal puncta, and dilating the duct from above downwards.

Fig. 9.



We would first direct attention to the accompanying woodcut, which will give a better idea of the anatomy of the lacrymal passages than the most elaborate description, and will, we trust, assist the operator in the performance of the following operation.

This proceeding consists in the slitting up of the punctum and in the passage of a probe through the lacrymal canal

into the nasal duct, and so on to the inferior meatus of the nose. The instruments required are furnished by instrument makers all together in a small case. They are, a small grooved probe-pointed director for opening the punctum upon, and three probes of a different size at either end, running from No. 1, the smallest, to No. 6, the largest.

The directions we are about to give for performing the operation, are taken from Mr. Bowman's paper on "Lacrymal Obstructions," in the Ophthalmic Hospital Reports for October, 1857.

The head of the subject being raised, the surgeon stands behind and bends over. For dividing the left lower punctum, the ring finger of the left hand is placed on the skin over the lower edge of the orbit, and fixes it there, while tightening or relaxing the lower canal by a sliding movement of the skin upon the bone — the punctum being at the same time everted. The right hand now inserts the probe-pointed director while the canal is relaxed, and then places the director between the index finger and thumb of the left hand, which holds it in the canal and further everts the punctum, by turning the probe downwards on the cheek, while the ring finger stretches and fixes the canal by a sliding movement of the skin outwards towards the malar bone. A fine sharp-pointed knife, held in the right hand*, now slits up the canal on the everted conjunctival aspect, from the punctum as far as the caruncle, and the probe is raised on its point out of the canal to make sure that the edge of the punctum has not escaped division.

In passing the probe through the canal, the instrument should be handled very delicately, and the canal held by the surgeon in the same way as when the puncta have to be slit, and he should of course have in his mind's eye at-

* See fig. 4, page 5, for the manner of holding the knife.

the moment the anatomy of the parts with which he is dealing. No *force* should be used.

If No. 6 will not pass, No. 4 or No. 2 may be tried. The canal should be stretched lengthwise as the probe reaches it, as its passage is thereby facilitated, for it is easy to fold the canal before the point of the probe. The greatest care is taken to proceed gently and not too rapidly, as a false passage may easily be made, or the walls of the canal torn. If the probe is arrested at the point where the canals coalesce and join the sac, the fact may be known by noticing that the skin near the tendo oculi is moved when the probe is moved, and an elastic resistance is experienced; whereas if the probe has entered the sac, it hits against the inner bony wall, and the skin is motionless.

When the probe is introduced in this method from the canal, it enters the sac *behind* the tendo oculi, and is in a better position for *finding*, as it were, the orifice of the nasal duct. But to make this more easy, the larger probes (Nos. 5 and 6, which are only used for this purpose) are slightly curved at each end in two different directions, while the central part (that held by the finger and thumb) is straight, and they are cylindrical in their whole length.

The effect of this is that when the probe is inserted into the sac, and brought into a vertical position, a slight rotation of it on its long axis makes the lower point, which is in search of the orifice of the duct, describe a small circle, and by slightly varying the inclination of the probe, and making gentle pressure at the same time with slight rotation, the point never fails to enter the duct. The point is known to have reached the nostril by the depth it has entered, compared with the external position of the nostril, and by its coming in contact with the floor of the nose.

Removal of the eyeball.—As this operation is now no longer confined to the speciality of ophthalmic practice, but

has become one of general operative surgery, and since it can be advantageously practised on the dead body, we shall describe the method of its performance, adopting Mr. Dixon's modification of the new operation. A curved pair of scissors, a blunt hook, forceps, and a spring-wire speculum, are necessary for its performance. Having inserted the spring speculum between the lids, make a circular division of the conjunctiva with the scissors, about a quarter of an inch behind the cornea. Raise the external rectus muscle, and cut it across; an assistant should seize the divided tendon and draw the eye inwards*, "sliding one blade of the scissors beneath the superior rectus and oblique muscles, they are divided, and then the inferior rectus; the optic nerve is next snipped through, and the globe starts forwards. Two or three strokes of the scissors divide the internal rectus, vessels and bands of areolar tissue, and the operation is complete."

Artificial anus. — The large intestine presents three points where, without injury to the peritoneal sac, it can be opened to give exit to its contents in cases of intestinal obstruction. An artificial anus may be formed in the cœcum or ascending colon; but the most favourable situation for this aperture is in the left lumbar region over the descending colon. The portion of the intestine here within reach, is limited above by the lower border of the kidney, and below by the crest of the ilium; at this point the gut lies upon the aponeurosis of the transversalis muscle, to the outer side of the quadratus lumborum, and behind the peritoneal sac and mass of the small intestines.

The subject being turned over on its face, the loins may be rendered prominent by placing a block or two beneath the belly. Retractors, scalpel, forceps, sutures, and director, are required.

* Dixon, Diseases of the Eye, page 393, 2nd edition.

Amussat's operation. — A transverse incision should be made an inch above the posterior part of the crest of the ilium, beginning at the external border of the erector spinæ, and extending outwards for three or four inches; the skin and superficial fascia being divided, the latissimus dorsi, and perhaps a portion of the external oblique muscle, will come into view: these, together with the fascia of the internal oblique and transversalis, should be divided on the director, and the loose subperitoneal tissue will be reached; in this, search for the intestine with the point of the director, and having found it, draw it out of the wound to a small extent; its edges being transfixed by sutures and united to the integuments, it may be opened at its most prominent part, and the operation will be complete.

The ascending colon may be exposed by an incision made in the right loin, in the same manner as described above. To open the *cæcum*, a wound should be made in the abdominal wall about three inches in extent, commencing an inch above the right anterior superior spine of the ilium, and extending downwards in the direction of Poupart's ligament.

CHAP. III.

TENOTOMY.

Tenotomy.—General Remarks.—Operation for Strabismus.—Division of the Sterno Mastoid, Tibialis Anticus, Hamstring Tendons, Tendo Achillis, Tiabilis Posticus.

TENOTOMY is an operation which in all practicable cases must be performed subcutaneously; it is with this object that a series of knives have been invented, allowing of the division of tendons with but little exposure of the wound to the external air.

The only instruments required for the performance of the following operations, with the exception of that for strabismus, are a sharp-pointed and a blunt-pointed tenotomy knife. The former is used for perforating the skin over tendons, and for dividing tendons themselves where there are no important parts within reach of injury. This knife is held as a pen*; it should penetrate the skin on the flat, that is with the flat of the blade parallel to the line of the tendon. When in contact with the tendon, its edge should be turned at right angles to the former, and in this position the tendon should be divided. The blunt-pointed knife is for dividing tendons, such as those of the tibial muscles, where there are important parts in the neighbourhood which are exposed to injury; it is held in the hand and used in the same manner as the sharp-pointed knife.

In dividing a tendon, the end of the thumb should be

* Page 4, fig. 1.

placed over it while the knife is beneath it. In this manner the operator can ascertain when the division of the tendon is nearly completed, and can thus exercise greater care to guard the skin from injury as the knife approaches the surface.

The duties of an assistant in this operation are, firstly, to put the tendon on the stretch, to enable the operator to ascertain its exact position; secondly, to relax it, allowing of the insertion and adjustment of the knife; thirdly, to tighten the tendon while the operator divides it. The completion of the section can be ascertained by the sudden relaxation of the parts, by the creaking of the tendinous fibres under the knife, and often by the obvious gap remaining in the course of the tendon from the retraction of its ends.

The following operations should be undertaken while the body is yet fresh, either before or immediately after the operations on the arteries.

Division of the internal rectus muscle of the eye.—We have selected this muscle for the description of the operation for strabismus, as its division represents the proceeding usually required in that affection.

A spring-wire speculum, a pair of blunt-pointed small scissors, two pair of forceps, the one broad-pointed for holding the eye, the other being ordinary dissecting forceps, and a blunt hook, comprise the list of instruments necessary for the operation.

The operator should stand facing the subject, and the assistant behind the head, facing the operator. Having introduced the wire speculum between the lids, the assistant should, with the broad-pointed forceps, grasp a fold of the conjunctiva on the outer aspect of the eye and rotate the ball outwards so as to expose the inner part of the white of the eye. Let the operator now pinch up with the

forceps the conjunctiva, about one-third of an inch to the inner side of the cornea, and below the situation of the tendon of the inner rectus muscle; this fold of conjunctiva should be divided to the extent of about a quarter of an inch, in a direction radiating from the circumference of the cornea, and parallel with the lower border of the rectus. Having cut through the subconjunctival tissue in the same direction, pass the blunt hook into the wound, gliding its extremity on the eyeball, downwards, backwards, and lastly upwards, so as to pass beneath the lower border of the tendon of the rectus. Lift the tendon upwards, away from the ball of the eye, and pass the scissors down the hook into the wound, and divide the tendon beneath the conjunctiva by a series of snips, cutting from below upwards. The hook may be again inserted, and any remaining fibres caught up and divided in a similar manner.

The difficulty in this operation is to pass the point of the hook beneath the lower border of the muscle; this may be obviated by passing the hook some distance backwards before attempting to catch the tendon.

The foregoing proceeding may be applied to any of the recti muscles of the eye; the incision in the conjunctiva being made in each case, in a direction radiating from the circumference of the cornea.

Division of the sterno mastoid.—This operation is undertaken for the cure of certain cases of wry neck, and is generally put in practice on the lower third of the muscle, which at this part is covered by the skin, platysma, cervical fasciæ, and its own sheath; it is crossed obliquely from within outwards and above downwards by the external jugular vein, though generally at a point higher in the neck than that selected for its division. The operation may be performed in two ways; for the first method, a

deeply grooved director, a narrow, probe-pointed, curved bistoury, and a small scalpel are required. The operator should stand, in dividing the muscle of the right side, facing the subject and on the same side of the body as that of the muscle which he is about to operate upon. The assistant should hold the head in such a position as will render the muscle tense.

Let an incision be made with the scalpel on the anterior border of the sterno mastoid in its lower third, and extending down to the muscular fibres: this wound should be sufficiently large to admit the point of the grooved director. Pass the director into the wound, and turning it round the border of the muscle, push it with a semirotatory movement from within outwards under its deeper surface, until the point can be felt in the neck, beyond the outer border of the muscle. The director may now be entrusted to the assistant, and a bistoury be carefully pushed along the groove to its extremity. Divide the muscle from its outer to its inner border, and from its deeper to its more superficial surface; keeping the fingers of the left hand over the skin of the part, to ascertain when the muscle is completely divided, and to guard against the possibility of the bistoury cutting its way through the integuments.

The more usual, but perhaps less safe method of dividing the mastoid is practised in the following manner: A sharp and a blunt-pointed tenotomy knife being procured, an incision is made down to the anterior border of the muscle; through this the blunt-pointed straight knife is introduced on the flat, and carefully passed in the same position behind the muscle; its edge being turned towards the muscular fibres, they are divided in the same manner and with the same precautions as were recommended in the preceding operation. Great care must be exercised in passing the knife or director, as the case may be, to keep it close to

the posterior surface of the muscle, and not allow it to include any of the deeper structures.

Division of the tendon of the tibialis anticus. — The spot which is usually selected for division of this tendon for club foot, is just in front of the ankle joint where the tendon is most prominent. Here it lies on the tibia, in the innermost of the sheaths in front of the ankle, having the anterior tibial artery to its outer side but separated from it by the extensor proprius pollicis.

The foot being abducted and extended by an assistant, the operator, standing on the opposite side of the leg to that of the tendon which he wishes to divide, and facing the patient for the muscle of the right side *, should feel for the prominence of the tendon with the forefinger of the left hand; keeping his finger on this spot, he should make an incision with the sharp-pointed knife, straight down to the inner side of the tendon, the blade of the scalpel being parallel to the latter; let him now introduce the blunt-pointed knife, and having passed it on the flat beneath the tendon, let him turn its edge and divide the tendon at a right angle, while the assistant puts the parts on the stretch. The usual precautions must be adopted for guarding the integuments from injury.

The body being turned on its face, the remainder of the operations enumerated at the commencement of this chapter can be performed.

Section of the hamstring tendons. — The *biceps* may be divided where it lies in the outer fold of the popliteal space, external to and overlapping the peroneal nerve. The operator should stand on the same side of the limb as the tendon which he is about to divide, and with his back

* His back being towards the body in operating on the muscle of the opposite side.

turned towards the subject in operating on the right leg. Placing the forefinger of the left hand on the prominence of the outer hamstring, an incision should be made immediately over and down to the tendon; through this the blunt-pointed knife should be introduced on the flat, so as to glide along the inner side of the tendon, between it and the peroneal nerve. The edge of the knife being turned, and the leg extended, the operation may be completed in the usual way.

The semimembranosus and semitendinosus can be divided in the popliteal space exactly opposite to the spot selected for section of the biceps, i. e. opposite the condyles of the femur. These tendons, lying in the inner fold of the space, are not in close relation with any important part; of the two, the semitendinosus is to the outer side, and communicates a more cord-like sensation to the touch. The operator should stand on the same side of the limb as the tendons on which he operates, and should face the subject in dividing those of the right lower limb. In operating on either tendon an incision should be made immediately on its outer * side, and the blunt-pointed knife being introduced, the operation may be completed as in the section of other tendons.

Division of the tendo Achillis. — The foot being put in a position of extension over the edge of the table, the operator should take up his position outside the limb, and in operating on the right leg, with his back turned towards the body: he should pierce the skin with a pointed tenotomy knife about an inch and a half above the calcis, and on the opposite side of the tendon to that on which he stands, and passing it beneath the tendon, should divide the latter, while the end of the thumb is placed on the skin over the

* "Outer" as regards the median line of the body.

parts; the assistant in the meantime putting the foot in a position of flexion to stretch the tendon.

It is customary with some operators to introduce the scalpel on the dorsal surface of this tendon, and this is best effected by pinching up the skin on the back of the heel, while the parts are relaxed, and subsequently cutting from the superficial towards the deeper aspect of the limb.

Division of the tibialis posticus. — The tendon of this muscle is found behind the inner ankle, in a groove on the tibia, and nearer to the inner malleolus than the other tendons; it is separated from the posterior tibial artery and nerve, which lie behind it, or nearer to the os calcis, by the flexor longus digitorum. The point usually selected for its division is at a spot about an inch and a half above the inner malleolus, immediately behind which point of bone the tendon is found. The foot being flexed and placed in a position of forced abduction, the line of the tendon should be felt for, and having been determined, the forefinger of the left hand should be placed on the spot, and retained there during the operation. The operator, standing on the opposite side of the leg to that of the tendon, should introduce the sharp-pointed tenotomy knife to its inner side, and thrust it quite down to the bone; having substituted a blunt-pointed knife, the tendon may be divided from within outwards, taking care not to pass over it, as it lies in its groove on the bone.

CHAP. IV.

LIGATURE OF ARTERIES.

General Rules for the Ligature of Arteries.—Instruments required and their respective use.—Ligature of Arteries of Upper Extremity and Head and Neck : radial, ulnar, brachial, axillary, subclavian, innominate, common carotid, external carotid, internal carotid, lingual, facial, temporal.—Arteries of Abdomen and Lower Extremity: common iliac, internal iliac, external iliac, femoral, anterior tibial, posterior tibial, peroneal, popliteal.

To expose the large vessels of the body with certainty, it is necessary not only to know their relational anatomy as regards the parts with which they are in immediate contact; but accurately to ascertain their position, and the direction of their course with respect to the external conformation and outline of the parts of the body in which they are found. With this object it is usual to take as guides and landmarks to the position of subjacent vessels, either the outline of some muscle, or imaginary lines drawn from one point to another. In all cases where the external conformation of the limb admits of it, we have chosen prominent points of bone as landmarks; as these are more constant in their relative positions, and more easily discovered than the outlines of muscles, which latter are too liable to be obscured by fat, or rendered indistinct from other causes.

The subject being placed on its back on a narrow table, the operator may prepare to perform the ligature of all the principal arteries of the body. He will require a scalpel,

a pair of dissecting forceps, a grooved steel director, and an aneurism needle. The scalpel should be from two to three inches in length in the blade. The groove in the director should run quite to its extremity, and leave no cul de sac in which the point of the knife can catch.

As there are certain general rules which must be followed in attempting the ligature of all arteries, we propose to notice them here, to avoid subsequent repetition.

The *knife* is for cutting, and for this alone, it should not be used for scraping or scratching at the sheath of a vessel; it had best be laid aside so soon as the artery comes into view. When the direction and length of incision have been determined, the integuments should be slightly stretched by the middle finger and thumb of the left hand, placed on either side of the line of incision. The *scalpel* should be held as a pen in writing (fig. 1, page 4), and on its first contact with the skin should be held at the same inclination to the surface as a pen; as the integuments are divided, its position should gradually become vertical, so that on the completion of the incision it may be perpendicular to the surface. When practicable the first incision is always made immediately over and parallel to the course of the vessel to be tied; it should not divide more than the integuments. Each successive cut ought to be of precisely the same extent as the preceding.

The use of the *forceps* is obvious, but it may be well to remark that they are not to be applied directly to the artery itself, or to any large nerve or vessel that may be exposed during the operation.

The *steel director* is used for dividing fasciæ upon, for separating muscular interspaces, and for detaching the artery from its sheath; it is of great service in all those cases in which a silver knife is used by many operators. In ex-

posing a vessel, as a general rule, intervening fasciæ are divided on the director*, which is inserted through a small hole, made by pinching up the parts with the forceps, and cutting with the blade of the knife on the flat. Muscular interspaces, if large, are most conveniently separated with the forefingers, contiguous tendons with the point of the director.

To free the vessel from its sheath, a small hole must be made in the latter, as in opening a fascia; the margins of this aperture being alternately seized with the forceps, the point of the director should be insinuated between them and the coats of the vessel. This separation ought to include the whole circumference of the artery, but as little as possible of its length.

An aneurism needle, with a very large curve, will be found most convenient on the dead body; besides its obvious purpose, it may, in its passage round the vessel, separate any remaining adhesion between this and its sheath. In passing the ligature, the point of the needle is generally inserted between the vessel and any neighbouring structure there may be a risk of including in the ligature. Having withdrawn the needle and left the ligature in position, a single knot should first be formed, and the ends of the silk be grasped by the thumbs and forefingers passed down as near to the vessel as possible; the knot may now be drawn tight, and secured by a second, tied over it. It is essential to pass the fingers down to the vessel before tightening the ligature, in order to avoid disturbing its connections, and also the more accurately to appreciate the amount of force applied.

We shall describe the operations for ligature of the various arteries in the order in which they should be practised on

* Fig. 4, page 5.

the subject, and shall omit those which rarely, if ever, come under our notice on the living body.

The radial artery.— The course of this vessel will be sufficiently accurately indicated, by a line drawn from midway between the condyles of the humerus to a point, half an inch internal to the styloid process of the radius at the wrist. In the upper third of its course, it lies between and is somewhat overlapped by the supinator longus on the outer side, and the pronator teres on the inner side; but lower down in the forearm it is found more superficially, between the tendons of the flexor carpi radialis on the inner, and the supinator longus on the outer side. In the whole of its course under consideration, this vessel is found in the outermost intermuscular space of the front of the forearm, and is covered by nothing but the integuments and deep fascia, or rather it is only necessary to divide these to expose the artery.

A ligature may be applied to this vessel in any part of its course: we propose to tie it in its lower and upper thirds.

Lower third.— An incision should be made in the direction of the line above indicated, commencing three inches above the wrist, and extending downwards for two inches. This should fall between the tendons of the flexor carpi radialis and the supinator longus; immediately beneath the integuments the superficial radial vein is usually found.

Pushing this aside, divide the deep fascia on the director, and the artery will come into view, surrounded by its venæ comites and an imperfect sheath, both of which must be separated with the point of the director, and the ligature passed.

Upper third.— To tie the artery in its upper third, make an incision three inches long in the course of the vessel, commencing two inches below the bend of the elbow and

running towards the wrist, search for the most external white line in the deep fascia; this marks the intermuscular space in which lies the artery. Having opened the fascia at this spot, use the finger or the director to separate the muscles, clear the artery from its connections, and apply the ligature from without inwards, to avoid the possibility of including the radial nerve.

The ulnar artery, in the part of its course with which we are concerned, extends with a slight curve from the middle of the bend of the elbow to the radial side of the pisiform bone. In the first part of its course it runs obliquely; here it passes beneath the muscles coming from the inner condyle, and above the flexor profundus. In the lower two thirds of the forearm, it is found on the latter muscle, and overlapped by the flexor carpi ulnaris; its nerve joins it about the middle of the arm, and continues with it on the ulnar side as far as the wrist. Practically, this artery can only be tied in the lower two thirds of its course; to expose it between the flexor sublimis and flexor profundus digitorum, in the upper part of the forearm, would necessitate a most unwarrantable division of soft parts. It must be approached through the innermost intermuscular space of the front of the forearm, that is between the flexor carpi ulnaris and flexor sublimis digitorum.

To expose the artery in its *lower third*, an incision should be made in the line of the course of the vessel, commencing three inches above the wrist, immediately external to the tendon of the flexor carpi ulnaris, and extending downwards parallel to that tendon for rather more than two inches; care should be taken to avoid injuring the superficial ulnar vein. By dividing the muscular fascia, the border of the tendon of the flexor carpi ulnaris will come into view, beneath which the artery lies. The vessel being

cleared, the aneurism needle should be passed from its ulnar to its radial side, to avoid the chance of including the ulnar nerve in the ligature. The operation is much facilitated by bending the wrist directly the above-mentioned tendon comes into view, as this permits the tendon to be drawn inwards without difficulty.

Ulnar artery with middle third.—Here the artery lies more deeply, and is approached by making an incision two or three inches long, to the radial side of the inner margin of the forearm, in the direction of the vessel: beneath this spot the white line which marks the separation between the flexor carpi ulnaris and flexor sublimis must be sought, and here the muscular fascia must be divided. After separating these muscles, the ulnar nerve will probably first come into view; and to its radial side, overlapped by the flexor sublimis, will be found the artery.

The brachial artery, extending from the lower border of the tendon of the teres major to the bend of the elbow, is covered, except at the last-mentioned place, only by the integuments and deep fascia; at the elbow it has in addition a covering from the tendon of the biceps, generally termed the semilunar fascia. A line, drawn from the inner border of the coraco brachialis to the middle of the bend of the elbow, would indicate its course; or the inner border of the biceps muscle sufficiently nearly represents it. The vessel lies for some distance on the triceps, and for a short space, just above the elbow on the brachialis anticus; to its outer side in the upper third of the arm, is the coraco brachialis, and below this point the biceps. Near the commencement of the artery, the median nerve crosses it in front, and runs on its inner side to the bend of the elbow. It is worthy of remark that the basilic vein lies over the vessel in the whole of its course; it may be found either in the subcutaneous tissue, or beneath the deep fascia. We pro-

pose to tie this artery at the bend of the elbow, and at two points in the upper arm.

Bend of the elbow.—Here the artery is very near the surface, being covered by the skin, superficial fascia, and deep fascia, which is blended with the semilunar fascia of the biceps; the vessel lies between the tendon of the latter muscle and the median nerve. To expose it, make an oblique incision, beginning two inches above the bend of the elbow, parallel to the inner border of the biceps, and corresponding to the line of the artery; push aside the median basilic vein, and divide the fascia of the biceps on the director; the artery will be found immediately beneath. In this operation, care is required both in dividing the integuments and the semilunar fascia; for beneath the former is the basilic vein, while the latter covers the brachial artery. The aneurism needle should be passed from within outwards.

The brachial artery is reached in its middle third by an incision from two to three inches in extent, along the inner border of the biceps muscle. The skin, superficial, and deep fascia will have to be divided, and the basilic vein carefully avoided. The vessel will be found with the ulnar nerve to its inner side, the median nerve either bearing the same relation to it, or lying in front of it. The sheath of the biceps should not be opened in this operation; it is a gratuitous injury, and adds to the difficulty of exposing the vessel.

The upper third of the brachial trunk may be ligatured by making a cut three inches long, beginning beneath the anterior fold of the axilla, and running down the inner margin of the coraco brachialis and biceps. The subsequent steps of the operation are precisely the same as those described in the preceding paragraph.

The axillary artery extends from the lower border of the first rib, to the lower border of the tendon of the teres

major muscle ; it presents two points at which a ligature can be applied,— viz., immediately below the clavicle, and at the lower part of the axilla. It is covered in its whole course by the pectoralis major, is crossed about its middle by the pectoralis minor, has the axillary vein to its thoracic side and in front of it, with the brachial plexus at first above, and subsequently surrounding it more or less.

Below the clavicle the vessel is covered by the integuments, platysma, pectoralis major, and deep fascia, the fascia of the pectoral muscle, and the costo-coracoid membrane ; it lies deeply, between the brachial plexus above, and the axillary vein below ; is crossed from above downwards by the two anterior thoracic nerves, and obliquely from without inwards by the cephalic vein ; between it and the first intercostal space runs the long thoracic nerve. In the *lower part of the axilla* the artery is generally covered by the confluence of the basilic vein with the venæ comites, and has on its inner side the ulnar and two internal cutaneous nerves, and often one root of the median. On its outer or acromial side is the coraco brachialis, the external cutaneous nerve, and sometimes the outer root of the median nerve. Occasionally the two roots of the median unite in front of the artery at this spot. From what is stated above, it is evident that the ligature of the axillary trunk is no easy task : it may be well to mention that in the succeeding operations, the knife should be used as little as possible, the point of the director being put in requisition for the separation of the deeper parts.

Ligature in the lower part of the axilla.—The arm should be raised above the head, so as to expose the cavity of the axilla, and an incision made along the inner border of the coraco brachialis, in the direction of that muscle. The axillary and deep fasciæ should be divided on the director, and the knife laid aside : the artery should now be sought and

cleared from its connections with the point of the director, and the ligature be applied from within outwards.

To tie the axillary artery in the first part of its course, that is, immediately below the clavicle.—The shoulder should be raised, and an incision made through the integuments to the extent of three inches, along the lower border of the clavicle, commencing an inch from its sternal end. The platysma, the upper layer of the fascia of the pectoralis major, the muscle itself, and the lower layer of its fascia, must be divided in succession; this will expose the costo-coracoid membrane, which must be laid open with great care on the director. The knife may now be laid aside, and the director used for separating the vein, to be plainly seen in the lower part of the wound, from the brachial plexus above; behind and between these two will be found the axillary artery; its connections being *torn* through, the needle may be passed from below upwards, and the parts examined, to ascertain that none of the brachial plexus is included in the ligature.

In the preceding operation the cephalic vein will probably come into view, after the division of the platysma: it may be most conveniently disposed of by drawing it upwards towards the clavicle. The pectoralis minor, which generally crosses the artery immediately below the spot at which we have applied the ligature, is sometimes found nearly covering the artery in this part of its course. Should this irregularity occur, the insertion of the muscle must be divided to an extent requisite for laying bare the vessel.

The subclavian artery, so far as it concerns us in operative surgery, may be considered to commence on *both sides* of the body, behind the sterno-clavicular joint, and to extend in an arched direction as far as the lower border of the first rib; for it is only within these limits that a ligature can be applied.

There are two points at which it is thought justifiable to attempt to expose the vessel,—namely, between its commencement and the inner border of the scalenus anticus, and from the outer border of this muscle to its termination. The part *internal to the scalenus* runs in a curved direction over the apex of the lung, and is covered by the integument and superficial fascia, the cervical fascia, the sternal portion of the sterno-mastoid muscle—a deeper layer of fascia, and the sterno-hyoid and sterno-thyroid muscles. It is crossed from above downwards by the pneumogastric nerve and filaments of the sympathetic, and, just external to these, by the internal jugular, and not infrequently by the vertebral vein. Beneath that part of the vessel nearest the trachea, is found the recurrent laryngeal nerve, running upwards and towards the middle line of the body. It is sufficiently obvious that it is a matter of some difficulty to ligature this part of the artery without injury to the neighbouring structures; indeed on the left side, the operation requires the greatest care even on the dead subject. On this side of the body the vessel lies deeper than on the opposite side, and being less transverse in its direction, is more completely obscured by the internal jugular and vertebral veins.

That portion of the subclavian which lies *external to the scalenus*, inclines downwards and outwards, is covered by the integuments and platysma, the cervical fascia, and the clavicular attachment of the omohyoid muscle; it is crossed superficially from above downwards, by the external jugular vein, and by some unimportant branches of the superficial cervical plexus. The vessel lies on the first rib, with the brachial plexus close above it, and the subclavian vein a short distance from it below; it is not infrequently crossed at this point by the supra-scapular vein,

and it may be overlapped by the outer border of the sterno-mastoid muscle.

To tie the artery *external to the scalenus* the shoulder should be depressed, the head thrown back, and an incision made along the upper border of the clavicle, beginning at the posterior border of the sterno mastoid, and extending outwards for three inches; the skin and platysma being divided, the external jugular vein will generally be exposed; turn it aside, and divide the deeper layers of fascia. Having laid aside the knife, search with the forefinger of the left hand for the external border of the scalenus anticus, and trace it downwards to the first rib: while the finger is kept on the tubercle of the rib that marks the attachment of the above-mentioned muscle, the point of the director should be employed to expose the artery, which lies immediately behind and rather external to the point where the scalenus joins the first rib. Detach the vessel from the brachial plexus, and pass the ligature from above downwards, as there is but little danger of including the subclavian vein, which, indeed, need not be seen during the operation.

The subclavian having been tied on the living body, *internal to the scalenus*, by several surgeons of the highest reputation, we shall not venture to omit the description of this operation. The head being in the same position as in the preceding operation, make an incision along the anterior border of the sterno-mastoid muscle, beginning two inches above its insertion and ending at the sternum; let it be joined at this point by a cut of the same length, running along the inner end of the clavicle and reflect the flap thus formed; divide the fascia and the sternal attachment of the mastoid muscle, the sterno-hyoid and sterno-thyroid; with the point of the director separate the cellular tissue from the deeper parts and search for the vessel just

above the sterno-clavicular joint. If the operation be on the right side of the body, in all probability the carotid will be first exposed, and this may be traced down to its origin, on the outer side of which lies the subclavian. The ligature is to be applied to that part of the vessel which is between the internal jugular vein and the origin of the carotid; it should be passed from below upwards, and care should be taken lest the recurrent nerve be included with the vessel. In turning the needle around the vessel, it is well to bear in mind that the sac of the pleura is within reach of injury.

Ligature of the innominate artery.—This operation, though never yet successful in its result on the living body, yet, as it has received the countenance of many eminent surgeons, we shall describe the method of performing it. The vessel in question is from an inch to two inches in length, and runs from the arch of the aorta to the right sterno-clavicular articulation; its course is oblique, from left to right; at first lying in front of the trachea, but subsequently getting to its right-hand side. At its origin it is crossed by the left innominate vein, higher up it has the right vena innominata on its outer side, while behind and between the two is the right pneumogastric nerve. The head being thrown back and turned towards the left side, the operator should stand behind the left shoulder; an incision may be made, commencing at the upper border of the sternum in the mesial line, and extending up into the neck for three inches, along the anterior margin of the sterno-mastoid muscle; this incision alone may be employed, or another may be added, which should run along the upper border of the clavicle and join the first at the top of the sternum. The skin, the cervical fascia, the sternal attachment of the mastoid muscle, the sterno-hyoid, and sterno-thyroid muscles being divided in succession, the point of

the director should be used to break away the cellular tissue behind the sterno-clavicular joint, and to search between it and the mesial line for the innominate artery; should the subclavian or carotid trunks come into view, they will be recognised respectively by their direction, and they may be made use of as guides to the situation of the innominate, around which the ligature should be passed from without inwards.

The common carotids, in the study of operative anatomy, may be considered to have the same course and relations on both sides of the body; as that part of the left carotid which differs from the right is beyond the reach of the ligature. We may therefore consider that the carotid commences behind the sterno-clavicular joint, and extends as high in the neck as the upper border of the thyroid cartilage. Its course is indicated by a line drawn from between the angle of the jaw and the mastoid process, to a point half an inch external to the sternal end of the clavicle; the best line to follow, however, in making incisions for exposing the vessel, is that of the anterior border of the sterno mastoid. The vessel in the lower half of its course lies deeply and is overlapped by the sterno mastoid, its sternal origin, the sterno-hyoid, and thyroid muscles, besides the various layers of cervical fascia; after a short distance these muscles diverge, and it pursues its course more superficially to its termination; at a variable distance above the clavicle, the omohyoid muscle crosses the artery obliquely from without inwards. In the upper part of the neck the vessel is only separated from the integuments by the platysma, cervical fasciæ, and its own sheath; in front of its sheath is found the descendens noni nerve, with its communicating branches, while within the sheath, on the outer side of the artery, are the pneumogastric nerve and internal jugular vein.

Internally are found the trachea and larynx, and occasionally the lateral lobe of the thyroid body overlaps the artery in the middle of its course. A ligature may be applied to this vessel in any part of its course between the *above-mentioned limits*; but that part which lies opposite to the cricoid cartilage is usually selected as the most convenient point to expose the artery.

To tie the carotid at this point, make an incision along the anterior border of the sterno-mastoid, about three inches in length, and after dividing the platysma and the superficial and deep cervical fascia, the omohyoid will generally come into view; push this to the outer side and open the sheath of the carotid on the director, taking care not to injure the descendens noni nerve. With the point of the director separate the artery from the vein and vagus nerve on its outer side, and pass the ligature around it from without inwards, to avoid injuring the nerve. In performing this operation on the dead body, it is not uncommon for the internal jugular to be mistaken for the carotid sheath, and to be laid open on the director; though there is but little danger of this, except when the vein is flaccid and empty, and overlaps the artery.

The external carotid, extending from opposite the upper border of the thyroid cartilage to the interval between the jaw and the mastoid process, lies superficially in that part of its course which concerns us. The anterior border of the sterno-mastoid marks its direction and serves as a guide in making our incisions. The only structures covering the artery are the integument, platysma, and cervical fasciæ: it is crossed from without inwards by the hypoglossal nerve, and lies side by side with the internal carotid, which latter is on its outer and posterior aspect. The two vessels may best be distinguished, besides by their position, by the latter being without branches and larger

than the former. The point usually selected for ligature of this vessel, is just beyond its origin, and here it may be tied by an incision made over the anterior margin of the mastoid, commencing opposite the hyoid bone and running upward for about two inches; the skin, platysma, and cervical fasciæ being divided, the director should be used to clear the vessel, care being taken to avoid injuring the hypoglossal and descendens noni nerves. The internal jugular vein will be found on the outer side of the artery, and separated from it by the hypoglossal nerve. The ligature should be passed from without inwards.

The internal carotid only admits of being ligatured within a short distance of its origin; subsequently its course lies so deeply among the important structures, that an attempt to expose it would be unjustifiable. The various steps for exposing this vessel in the first part of its course are precisely those that are described above as necessary for ligaturing the external carotid. The ligature should be passed from without inwards to avoid the risk of injuring the vagus nerve, or the internal jugular vein.

The lingual artery, after leaving the external carotid, runs upwards and inwards beneath the posterior belly of the digastricus and stylo-hyoideus, to the upper border of the greater cornu of the hyoid bone, along which it pursues its course, lying on the middle constrictor muscle, and beneath the hyoglossus.

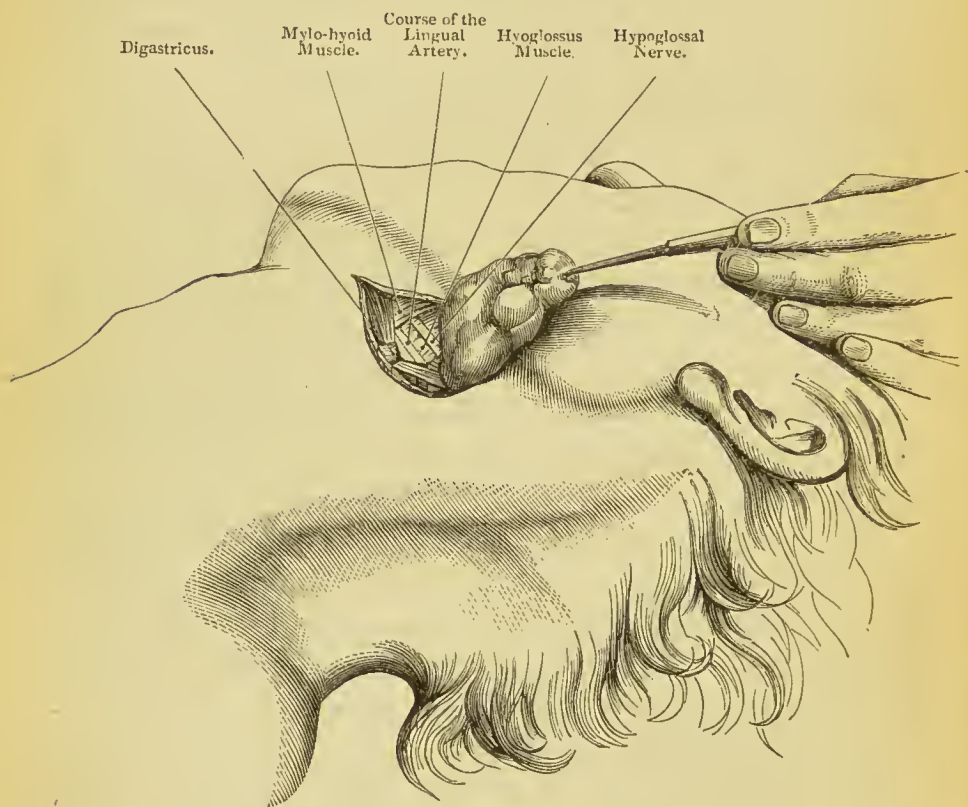
The portion of the artery with which we have to deal, is that lying beneath the last-named muscle. Here the vessel is covered by the skin, platysma, superficial and deep cervical fasciæ and hyoglossus muscles.

The anterior and posterior bellies of the digastricus at their divergence below, form with the hypoglossal nerve above, and the mylo-hyoidens on the inner side, a small space with its apex at the hyoid bone and its base above,

The floor of the space is covered by the hyoglossus muscle, and immediately beneath this will be found the lingual artery, the course of which is indicated by a dotted line in fig. 10.

To expose the artery, throw the head back, and turn the chin to the opposite side, and make a slightly curved

Fig. 10.



incision about two inches in length, commencing at the small cornu of the hyoid bone, and extending outwards and upwards along the upper border of its greater cornu. The skin, platysma, and cervical fasciæ being divided, the sub-maxillary gland will most likely come into view; this being turned upwards, until the hypoglossal nerve is seen, the

junction of the bellies of the digastricus must be sought, and the hyoglossus muscle divided transversely on the director, at the point before indicated: the artery will now be plainly seen, and the ligature can be placed around it.

The lingual artery may be exposed by other methods, but we have selected that operation which we have personally found most convenient and certain of success.

We shall omit any description of the course of the *facial artery*; as the only point at which its ligature is attempted, is where it crosses the lower jaw, at the anterior border of the masseter muscle. It is exposed by an incision an inch in length, parallel to the body of the lower jaw; crossing the anterior margin of the masseter muscle at the lowest point of its insertion. The skin, platysma, and fasciæ must be divided, and the artery carefully separated from its vein. The direction of the vessel will, of course, be at right angles to that of the wound.

The temporal artery.—The main trunk of this artery, after leaving the parotid gland, passes upwards over the zygoma, just in front of the pinna of the ear. To tie the vessel, an incision should be made an inch in length, just in front of the antitragus, and crossing the zygoma at right angles; the skin and fasciæ must be divided, and the vessel sought for in the dense cellular tissue which is found at this spot.

We propose to proceed with the ligature of the vessels of the trunk and lower extremities, in order, from above downwards, commencing with the common iliac artery.

The common iliac arteries, commencing at the bifurcation of the aorta on the left side of the fourth lumbar vertebra, extend downwards and outwards, diverging from each other, until just short of the sacro-iliac joint, where they give off the external and internal iliac trunks. The artery of the right side is thus rather longer than that of

the left; both lie on the inner border of the corresponding psoas muscle, and are crossed by the spermatic vessels and the ureter; the vessel of the left side has also in front of it, the inferior mesenteric artery, and the sigmoid flexure of the colon. The iliac veins are found internal to, and on a lower plane, than their companion arteries, and their junction is effected beneath the upper part of the right iliac artery. Both vessels are covered by the muscles of the anterior abdominal wall, and lie behind the peritoneal cavity and small intestines. A line drawn from the left side of the navel to the centre of Poupart's ligament on either side, pretty nearly indicates the direction of the course they pursue. To apply a ligature to this vessel, divide the integuments to the extent of five inches, beginning at a point an inch below and two inches nearer the middle line than the anterior spine of the ilium, and extending from this point upwards with a slight inclination outwards. The three abdominal muscles must be recognised and separately divided, and the fascia transversalis cautiously cut upon the director; the subperitoneal fat ought now to be seen, and from this stage of the operation the knife should be abandoned. An assistant should hold open the wound, while the operator raises the peritoneum and its contents with his left hand, pushing it upwards and inwards, and separating it from the iliac fossa with the point of the director, until the psoas muscle is reached. Immediately internal to this muscle, at the posterior part of the pelvic brim, the artery will be found; its connections being detached to a small extent, the aneurism needle, which should be of a suitable shape, may be passed from within outwards, as this best secures the safety of the corresponding vein.

Little thought need be bestowed, during the operation, on the spermatic vessels and ureter, as they generally rise

with the peritoneal sac, and adhering to its under surface, are scarcely observed.

We have described this operation as if performed on the right side of the body : on the opposite side its difficulty is increased by the presence of the sigmoid flexure of the colon, which crosses the vessel at its bifurcation, and must be raised before a ligature can be applied.

The internal iliac artery, leaving the common iliac at the sacro-iliac joint, runs downwards and forwards towards the great sciatic notch ; it is crossed in front by the ureter descending into the pelvis ; behind the vessel is found its corresponding vein with which it is generally pretty closely connected. The same operation is necessary for the ligature of this vessel as was described for the common iliac ; the artery, however, must be sought below the pelvic brim, and great caution will be required to clear it from the veins which often unite on its inner side.

The external iliac artery extends from the sacro-iliac joint to the centre of the crural arch ; following the brim of the pelvis for some distance, it lies to the inner side of the psoas muscle, and has its own vein internal to it, but on a lower plane. Just before its termination, this vessel is crossed at right angles by the circumflex ilii vein, and obliquely, about the middle of its course, by the genito-crural nerve : it lies behind the peritoneal sac and small intestines. This vessel may be tied at any part of its course ; we shall select a part of its trunk, about two inches above Poupart's ligament, as this is a sufficient distance from the origin of its branches, the epigastric and circumflex iliac.

Operation.—Make an incision about three inches in length, beginning at the centre of Poupart's ligament, and half an inch above it, running in a slightly curved direction, outwards and upwards towards the anterior superior

spine of the ilium. Divide separately the external oblique, the internal oblique, the transversalis and fascia transversalis. The subperitoneal fat having been exposed, push the peritoneum upwards and inwards, and search for the artery on the inner margin of the psoas: it may be easily cleared from its connections, and a ligature applied from within outwards. In this operation the connections of the peritoneum need only be disturbed to a very small extent.

The femoral artery.—From the crural arch, this vessel extends down the inner side of the thigh, to the opening in the adductor magnus muscle; its course is indicated by a line drawn from the centre of Poupart's ligament to the most prominent point of the inner condyle of the femur.* In *the upper third* of its course this artery has the femoral vein to its inner side for a short distance, and the anterior crural nerve on the outer side; it is here covered by nothing but the integuments, superficial and deep fascia, and its own sheath.

The middle third of the femoral artery has its companion vein behind it; and on the outer side, or in front, is the long saphenous nerve; it is covered by the sartorius muscle, in addition to the integuments and fasciæ of the thigh. The vessel here lies between the vastus internus on its outer, and the adductor longus on its inner side.

In *the lower third* of its course the femoral artery is found at the angle of meeting of the vastus internus and adductor longus; in front it is covered by the fascia forming Hunter's canal, which latter is overlapped by the sartorius.

This artery may be tied in any part of its course; we shall therefore describe the ligature of the vessel in its upper, middle, and lower thirds.

Upper third.—The limb being abducted, make an incision two or three inches in length, in the direction of the

* The point that gives insertion to the tendon of the adductor magnus.

line leading from the centre of the crural arch, to the prominence of the inner condyle ; divide the superficial fascia, fascia lata, and sheath of the vessel, clear the artery, and pass the ligature from within outwards.

Middle third.—Divide the integuments in the direction of the line before mentioned and to the same extent ; after laying open the superficial and deep fascia, the sartorius will come into view ; this being pushed outwards, lay open the sheath of the vessel and pass the ligature between the long saphenous nerve and the artery. There is occasionally a branch of the middle cutaneous nerve lying over the artery at this part of its course, which one should avoid injuring, though practically its division would be of but little consequence.

Ligature in Hunter's canal.—An incision should be made in the line of the artery, commencing about the middle of the thigh and extending downwards for three inches. After dividing the superficial and deep fascia, the sartorius will generally be seen, and this must be drawn to the inner side. The first finger should now be passed down the adductor longus towards its insertion into the linea aspera of the femur, until the point of the finger rests against the vastus internus, at the spot where it is blended with the former muscle. Carefully lay open the fascia which connects these two muscles, and separate the artery, which will now be seen, from the vein and long saphena nerve. Pass the ligature from within outwards, taking care that the vein which lies behind be not included, adhering as it does very firmly to the artery.

There is often considerable difficulty experienced in exposing the vessel in Hunter's canal, and this generally arises from one of two causes ; namely, either the first incision is made too low down in the thigh, or the line of the vessel, before mentioned, is not correctly ascertained

before commencing the operation. To avoid the inconvenience of turning the body, we shall omit for the present the ligature of the popliteal artery, and proceed to describe the operation for tying the anterior tibial.

The anterior tibial artery, entering the front of the leg through the interosseous membrane, beneath the head of the fibula, continues its course down the limb, to the first interosseous space on the dorsum of the foot. It lies successively on the interosseous membrane, the tibia, the front of the ankle joint, and over the astragalus, the scaphoid, and the internal cuneiform bone. In the upper third of the leg it is found deep between the tibialis anticus and the extensor longus digitorum; below this it lies between the former muscle and the extensor of the great toe, and on the dorsum of the foot it intervenes between the extensor proprius pollicis and the innermost tendon of the extensor longus digitorum. In front of the ankle joint the artery is crossed from without inwards by the long extensor of the great toe, and on the dorsum of the foot by the first tendon of the extensor brevis digitorum.

A line drawn from below the inner side of the head of the fibula, or rather from the centre of the muscular space between the heads of the tibia and fibula, to a point midway between the maleoli, indicates the course of this artery. The vessel in question is approached in any part of the leg through the innermost intermuscular space, the exact seat of which is indicated by a white line in the fascia, just external to, and nearly parallel with, the spine of the tibia. The artery can be tied in any part of its course; we shall describe the measures necessary for exposing it in its upper, middle, and lower thirds.

Ligature in the upper third.—An incision, three inches in length, should be made over the artery in the line of its course, beginning an inch below the head of the tibia; the

integuments, the superficial and deep fascia being divided, the subjacent muscular fibres must be separated with the handle of the knife, until the interosseous membrane is reached. The artery will be found on the membrane, and its nerve, if it should come into view, will be on the outer side. After clearing the vessel from its companion veins, the ligature may be passed from either side.

The separation of the tibialis anticus from the extensor longus digitorum is not always easily effected, as their contiguous margins are intimately connected. If, however, the line of the vessel be at first correctly ascertained and subsequently be rigidly observed, no difficulty will be found in falling on the artery at the bottom of the wound.

Ligature in the middle third. — The integuments having been divided to the extent of two or three inches over this part of the artery in the line of its course, the white mark which lies nearest to the tibia should be sought in the fascia, and over this spot the fascia should be opened. Separate with the director the tibialis anticus from the extensor longus pollicis, and the artery will be plainly seen with its nerve to the outer side; detach the venæ comites and pass the needle from without inwards.

Dorsum of the foot. — Here the artery, besides its coverings of skin and fascia, has closely binding it down a peculiarly dense layer of membrane, which connects the sheaths of the contiguous tendons. Its course corresponds to a line drawn from the front of the ankle, midway between the maleoli, to the centre of the first metatarsal space. To tie the vessel an incision should be made over the artery an inch and a half long, and about three inches in front of the ankle joint. Divide the integuments and deep fascia, and the tendon of the flexor longus pollicis will be exposed; lay open the fascia on the outer side of this, turn aside the

short extensor of the toes if it cross the vessel at this spot, and apply the ligature from without inwards.

The posterior tibial artery extends from the lower border of the popliteus muscle to the internal lateral ligament of the ankle joint; it is covered in the upper two-thirds of its course by the muscles of the calf and the deep fascia of the leg, in its lower third by the integuments and two layers of fascia. The vessel lies between the bones of the leg, being rather nearer to the tibia; in its upper two-thirds it is found on the tibialis posticus, and between the flexor longus digitorum and flexor longus pollicis; lower down it lies on the flexor longus digitorum, and lastly on the posterior surface of the tibia. The posterior tibial nerve, in all that part of the course of vessel which is within reach, is on its outer side.

Ligature of the posterior tibial in its upper part.—The leg being flexed and turned on its outer side, an incision should be made parallel to the inner border of the tibia, and half an inch behind that bone. This should be three or four inches in length, and ought only to divide the skin, as the internal saphena vein usually lies beneath this spot; turn the vein aside, and cut through the attachment of the solens to the tibia; now seek for the deep fascia of the leg which separates the last-named muscle from the tibialis posticus and deeper muscles of the part. Having recognised this fascia, divide it, and the artery will be found beneath, lying on the tibialis posticus, and surrounded by its companion veins, with its nerve to the outer side. Having cleared the vessel, pass the ligature from without inwards. This artery is sometimes tied by an incision made down the centre of the calf, dividing the muscles and deep fascia; but the objection to this operation is the great depth of the wound, and the very extensive division of muscular fibre which it involves.

In performing the operation which we have described, it is essential to success that the separation between the superficial and deep muscles be recognised; and on this account the tibial attachment of the solens should be carefully divided, in order to expose the deep fascia which stretches between the bones of the leg and separates the two groups of muscles.

Ligature in the lower third of the leg.—Here the posterior tibial artery lies on the tibia between the tendons of the flexor longus digitorum and the flexor longus pollicis; it is covered by the skin, superficial and deep fascia, and by the deep aponeurosis of the leg; it lies just midway in the space between the internal margin of the tendo Achillis and the inner border of the tibia. To tie the vessel a wound should be made, about two inches in extent, parallel with the posterior border of the tibia, and midway between it and the tendo Achillis; cut through the superficial and deep fascia, and carefully divide the deeper layer of membrane which binds down the tendons; the artery will be found beneath, lying on the bone, between the tendons of the longus digitorum and the longus pollicis, and surrounded by its veins. The posterior tibial nerve is nearer to the os calcis than the artery. The vena comites having been separated, the ligature should be passed between the nerve and the artery.

The peroneal artery follows pretty closely the line of the fibula, lying to its inner side on the posterior aspect of the limb. In the upper part of its course it lies on the tibialis posticus, and before long is overlapped by the flexor longus pollicis, in the fibres of which it generally pursues its course to the bottom of the leg. The leg being flexed and laid on its inner side, make an incision about three inches in extent along the posterior border of the fibula, rather above the middle of that bone. Divide the solens from its fibular

attachment, and lay bare the deep muscular fascia; open it and search for the vessel just behind the posterior border of the fibula. The ligature may be passed from either side, as there is no accompanying nerve.

The subject being turned over on its face, the operator should turn his attention to *the popliteal artery*.

This vessel, entering the space of the same name through the tendon of the adductor magnus, ends at the lower border of the popliteus. It does not pursue its course parallel with the long axis of the limb, but inclines slightly from within outwards until it ends exactly in the middle line of the popliteal space. Its course is expressed by a line drawn to the centre of the popliteal space, from a point four inches higher up the limb and an inch to the inner side of the middle line. The artery lies on the back of the femur, the posterior ligament of the knee joint, and the popliteus muscle successively; to its outer side and partially overlapping it is the popliteal vein, and still more external the popliteal nerve. The wound for exposing the vessel should be nearly four inches long, and should be slightly oblique in its direction from within outwards, terminating midway between the condyles of the femur. Care should be taken in making the first incision not to injure the posterior saphena vein. On dividing the integuments and fascia, the popliteal nerve will generally be seen; it should be drawn to the outer side, and the vessel sought for to its inner side, where it will be found lying deep in the popliteal space with its vein external to it. Separate the artery and vein, and pass the ligature from without inwards.

CHAP. V.

MEDIAN OPERATIONS.

Tracheotomy. — Laryngotomy.—Pharyngotomy.—Lithotomy : (1) lateral operation, (2) Allarton's method, (3) Mr. Lloyd's operation.

THE operations, which are described in this chapter, can only be practised once on the same body. They should be performed either immediately before or after the ligature of the arteries is completed ; at all events, they must not be long postponed, or their execution will both be disgusting, and will lose much of its advantage.

The trachea, so far as it concerns us in operative surgery, extends from the lower border of the cricoid cartilage to the first bone of the sternum.

In its passage down the neck it gradually recedes from the surface, and, from being at its commencement comparatively subcutaneous, it lies just above the first bone of the sternum, a full inch beneath the skin.

Though overlapped on either side by the depressors of the os hyoides, yet in the middle line, where it is always opened, it is covered only by the integuments, superficial and deep cervical fascia, a layer of membrane uniting the contiguous margins of the sterno-hyoid muscles, and some loose cellular tissue. About half an inch below the cricoid cartilage it is crossed by the isthmus of the thyroid gland, and from this point to the sternum it has the middle thyroid veins in front of it, as they run to join the left inno-

minate. In many bodies there is another large vein in front, immediately beneath the integuments, which takes the place of the anterior jugular.

The trachea may be opened either above the isthmus of the thyroid gland, or between this and the sternum, though in many cases the isthmus is so insignificant in size that any part of the tube may be safely exposed. The extent of that part within reach of the surgeon varies much in different bodies, depending upon the length of the neck.

Very little idea can be formed of the difficulty of this operation on the living, from its performance on the dead body; still its practice should not be neglected, as one can thereby acquire a familiarity with the appearance and arrangement of the structures covering the air-tube.*

Above the isthmus of the thyroid gland.—Here the trachea may be opened by an incision about an inch long, made in the mesial line of the neck, commencing at the lower border of the cricoid cartilage. The subjacent layers of fascia being cut with care, the isthmus of the thyroid gland may be pushed downwards if it obtrude itself, and the trachea opened by a longitudinal incision about three quarters of an inch in extent. The fore-finger of the left hand should be passed into the wound to ascertain the exact position and size of the opening, while the knife is laid aside and the tracheotomy tube taken in hand. This should be introduced with its convexity upwards, its point being first directed backwards and subsequently turned downwards, being guided by the fore-finger of the left hand.

Below the thyroid gland.—Divide the skin over the middle line of the neck for two inches, draw aside any veins that may show themselves, and lay open the cervical fascia and the fascia of the sterno-hyoid muscles. Surrounding the trachea at this point is usually found a layer

* A scalpel, forceps, and a tracheotomy tube are required for this proceeding.

of loose cellular tissue, which should be torn through, and the trachea opened and tube passed as in the preceding operation.

In opening the air tube at this point, it should be borne in mind that occasionally the innominate artery ascends high enough in the neck to be exposed to injury.

Laryngotomy.—The larynx can be opened only at the crico thyroid membrane. The extent of this membrane varies much in different individuals. It rarely measures more than half an inch from above downwards; and we have in one or two instances observed the distance between the thyroid and cricoid cartilages to be too small to allow of the passage of an ordinary tube.

The membrane in question is left bare in the mesial line of the neck by the divergence of the crico thyroid muscles; and this is the spot selected for its perforation. It is covered by the same structures as the trachea, and has in addition a fascia connecting the crico thyroid muscles. Occasionally a small artery, a branch of the superior thyroid, is found running across the membrane.

A scalpel, forceps, and a laryngotomy trochar and canula, or an ordinary tube, are required for this operation.

Make an incision an inch long in the middle line of the neck over the crico thyroid membrane, divide the subjacent fascia, and clear the centre of the membrane. Open the larynx either by a crucial incision with the scalpel, or by perforating it with the laryngeal trochar.

Pharyngotomy.—The alimentary tube can be reached at any part of its course in the neck, from the lower border of the thyroid cartilage down to a point within an inch of the upper border of the sternum. The part that is most convenient for the performance of the operation in question, is where the pharynx contracts itself and ends in the œsophagus, just below the situation of the cricoid cartilage;

here the œsophagus lies behind the air tube, in front of the spine and between the great vessels and nerves of the neck. The part of its course to which we refer is fortunately that in which a mass of unmasticated food or other foreign body is most likely to stick. The head of the subject being thrown back, and the chin turned towards the right side, the operator should stand on the same side of the body and make an incision on the left side of the larynx, commencing at the lower border of the thyroid cartilage and extending downwards for three inches, parallel with the mesial line of the neck; this cut should fall just over the interspace between the great vessels of the neck and the trachea. The platysma and cervical fascia being divided, the interval between the sterno-hyoid and omo-hyoid should be sought, and through this the operator should break his way with the point of the director, searching for the deeper part of the trachea; behind this the œsophagus will be found, and should be opened by a longitudinal incision. The operation is usually performed on the left side, on the ground that the œsophagus deviates slightly to this side in its course down the neck. Practically, this deviation is scarcely appreciable on the body.

Lithotomy.—We shall describe the operation commonly practised in this country, (1) the lateral operation, as it is called; (2) Mr. Allarton's method, and (3) Mr. Lloyd's. A stone having been introduced into the bladder through the anterior abdominal walls, and the wound both in the bladder and abdomen being sewn up, a grooved staff should be carefully introduced, and the body tied up with the soles of the feet to the palms of the hands, as in the ordinary position for lithotomy.

The instruments required for this operation on the dead body are the lithotomy forceps, a grooved staff, and a lithotomy knife.

The operator should sit down facing the perineum of the subject, which latter must be drawn to the edge of the table, so that the buttocks project beyond its margin.

It may be well before commencing, to pause for a minute, and consider what are the various steps in the operation. The operator must first satisfy himself that the staff is fairly in the cavity of the bladder; it must then be entrusted to an assistant, who should stand on the operator's right-hand side facing him. The assistant is to hold the staff vertically, and hook it up gently against the pubes, and draw the scrotum out of the way. The perineum is now to be carefully examined, to ascertain the position of the tuberosities of the ischia, and the relative situation of the staff as it passes beneath the pubic arch.

The operator has to divide the integuments, the superficial and deep perineal fasciæ; to make his way through the loose tissue between the urethra and rectum, to open the former at the junction of its membranous and prostatic portions, and to prolong the wound in the urethra for a short distance onwards towards the bladder. The wound has to be dilated, and the stone extracted.

A few ounces of water being thrown into the bladder*, make an incision from two to three inches in length, commencing in the median line of the perineum rather more than an inch in front of the anus, and extending downwards, outwards, and towards the left-hand side of the body, to a point midway between the tuberosity of the ischium and the margin of the anus.

The knife having penetrated pretty deeply into the fat of the ischio rectal fossa may be withdrawn, and the forefinger of the left hand introduced to feel for the staff; if any considerable thickness of parts remain undivided over the staff, the knife may be reintroduced and be used to assist

* If necessary the perineum should be shaven.

the finger in making its way to the membranous portion of the urethra. The staff being plainly felt, the knife, held in the right hand, should be guarded with the forefinger of the left, by laying it on its flat against the palmar surface of the finger, the edge being downwards, and the tip of the finger being slightly in advance of the point of the knife. Thus protected, the knife should be introduced; resting the end of the finger on the staff, the operator should guide the point of the knife into the groove, and push it onwards towards the bladder, so as to divide the prostate to a small extent on its under and left-hand aspect*; this wound should be of sufficient size to admit the finger with difficulty. Having stretched the wound in the prostate with the forefinger of the left hand to a sufficient extent, the staff should be withdrawn, and the forceps introduced as the finger is taken out of the wound. If there is any urine in the bladder, the stone may be grasped at once, but if the attempt to seize the stone on the first introduction of the forceps prove unsuccessful, the blades being closed, they may be used gently to feel for the stone; the subsequent effort to extract must be gentle and continuous, and should be made in a downward direction.

We venture here to remind the operator of some of the more common errors that one is likely to fall into in the performance of this operation, and the best means of guarding against these. Having first ascertained that the staff is in the bladder, on making the first incision care should be taken not to commence it too far forwards, or the bulb and its artery will be endangered, nor should it be prolonged too far backwards, lest the rectum be wounded: again, any considerable deviation outwards will bring the knife in dangerous proximity with the trunk of the pudic artery. In deepening the first incision, the position of the

* Left hand of the patient.

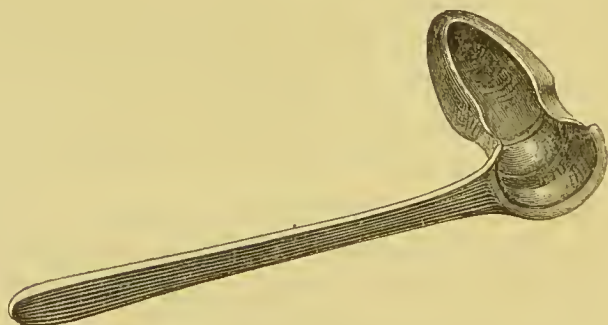
bulb and rectum should be borne in mind, the former at the upper, and the latter at the lower angle of the wound ; in incising the prostatic urethra, the cutting edge of the knife should be directed downward, outwards, and to the left-hand side of the body, and great care should be exercised lest, in prolonging the wound in the urethra, the point of the knife escape from the groove in the staff ; this latter is one of the most unfortunate accidents that can happen, as it leads to still greater difficulties. The staff should not be withdrawn until the operator feels certain that his finger is within the cavity of the bladder, and, if possible, in contact with the stone. Lastly, we would strongly recommend the operator to proceed to work quietly, and continue to the termination of the operation without any attempt at brilliancy of execution.

Mr. Allarton's operation.—The description of the method of effecting this we shall give in the author's own words : “ I introduce a grooved staff in the usual manner and of the usual size, and confide it to an assistant, with directions to keep it perpendicular and hooked up against the pubes ; I then introduce the index finger of my left hand into the rectum, placing its extremity in contact with the staff as it occupies the prostate, and press it firmly against the staff so as to steady it ; then, with a sharp-pointed straight knife, with a tolerably long and rough handle, I pierce the perineum in the middle line about half an inch in front of the anus*, or at such a distance as may appear necessary to avoid dividing the fibres of the external sphincter. I carry the knife steadily and firmly on till it strikes the groove of the staff, the deep sphincter lying between the knife and the directing finger, which enables me to judge of the distance as the knife passes along. Having struck the groove of the staff, I move the point of the knife along the groove

* The edge of the knife being turned upwards.

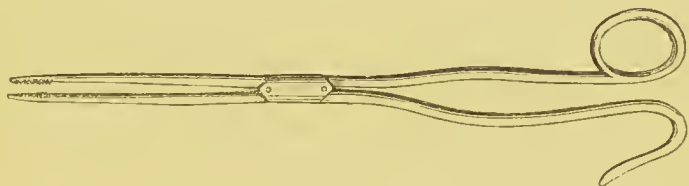
towards the bladder a few lines and then withdraw it, cutting upwards, so as to leave an external incision of from three quarters of an inch to one and a half inches, according to the presumed size of the stone; the escape of urine indicates the entrance to the urethra. I then introduce a long ball-pointed probe or wire through the external opening into the groove of the staff and slide it into the bladder, to sufficient depth to insure its safe lodgment in that viscus, and withdraw the staff. I then well grease the index finger of the left hand, and pass it along the probe with a semi-rotatory motion, through the prostate into the bladder, which procedure is accomplished without difficulty; and when the stone is free it comes in contact with the finger, and if of moderate size passes at once into the wound on withdrawing the finger." The forceps are introduced and the stone grasped, as in the lateral operation. The operation we have just described is a most excellent and comparatively safe method of extracting calculi, provided they are not of large size. For these latter Mr. Lloyd's operation is admirably adapted; this is performed in the following manner. The body being prepared, and a staff

Fig. 11.



introduced as in ordinary lithotomy, a metallic speculum, such as represented in fig. 11, is oiled and introduced into the rectum; the vacant space in the instrument being

turned upwards towards the pubes, it is retained in position by an assistant, who should stand on the right-hand side of the body. The operator now introduces a sharp-pointed narrow knife in the median line of the perineum, an inch in front of the anus, and cutting downwards through the vacant space in the speculum, he divides the external sphincter, and terminates his incision in the cavity of the rectum. The speculum is now withdrawn, and the finger placed in the bowel to guide the knife, which by cautious and successive cuts must make its way into the membranous portion of the urethra, which is opened in its whole extent, the prostatic urethra remaining uninjured. Mr. Lloyd now introduces a pair of forceps, such as are represented in the accompanying woodcut, with their blades

Fig. 12.

closed, along the groove in the staff, until they enter the bladder: disengaging them from the groove of the staff he now expands their blades, and passing the forefinger of the left hand between them into the bladder, he withdraws both staff and forceps, and dilates the urethral wound until of sufficient size to admit the lithotomy forceps, and allow of the extraction of the stone. The advantage this operation possesses in certain cases over Mr. Allarton's we conceive to be, that it gives greater room for the extraction of a large calculus; we have now before us two stones from Mr. Lloyd's collection, successfully extracted by this operation, the one measuring in its diameters two and a half by two inches, the other three by two inches.

CHAP. VI.

AMPUTATIONS OF THE UPPER EXTREMITY AND
REMOVAL OF THE BREAST.

Amputations of the upper extremity.—General remarks.—Various methods.—Instruments.—Assistant.—Anatomy of Phalangeal articulations.—Amputation of the phalanges at their various joints: by a palmar flap; by double flaps.—Amputation of first, second, and third fingers at their metacarpal joints.—Ditto of little finger at the corresponding articulation.—Removal of the fingers *en masse* at their metacarpal joints.—Amputation through third and fourth metacarpal bones.—Ditto through second and fifth.—Disarticulation of the thumb at its metacarpal joint.—Ditto of thumb at its carpal articulation.—Amputation of the hand at its carpal articulation, leaving the thumb.—Of the hand at the wrist-joint by a single flap; by double flaps.—Amputations of the forearm: (1) circular, (2) flaps, (3) combined method, (4) Tcale's operation.—Upper arm: (1) circular, (2) flap, (3) combined method, (4) Tcale's operation.—Removal of the upper extremity at the shoulder joint by anterior and posterior flaps; by upper and lower flaps.—Removal of the breast.

AMPUTATIONS are generally classed as those of continuity, or amputations proper, and those of contiguity, or disarticulations. The object in view in all methods of amputation is the same,—namely, after the removal of the part, to secure a suitable and sufficient covering for the end of the bone, to avoid adhesion between the latter and the cicatrix of the integument; to divide the large nerves and blood-vessels transversely, and to leave their cut ends in a part of the stump little exposed to pressure. Stumps are either formed of integuments alone*, or of muscular tissue

* By integuments we mean both skin and subcutaneous tissue.

and integument together; where the parts admit of it, sufficient muscle is detached to form a cushion around the end of the bone, and enough integument is reflected to cover the whole. The ingenuity of operators, and the varying necessities of different parts of the body, have given rise to four principal methods of amputation: (1) the circular; (2) the flap; (3) a combination of the two preceding operations; and (4) the oval method.

(1.) *The circular method* consists in the formation of a circular incision of the integuments in the entire circumference of a limb; the division of the muscles in the same manner, though higher up the limb, and in the section of the bone at a point still nearer the body. It has its advantages in a comparatively small external wound and a transverse division of the large blood-vessels of the part; on the other hand, the resulting cicatrix is liable to be opposite and adherent to the extremity of the bone, and the operation takes a longer time, and requires more care in its execution than the flap method.

(2.) *The flap amputation* consists in removing a limb by double flaps, of which the one is generally anterior, the other posterior, or by forming a single anterior or a single posterior flap. These flaps include all the soft parts of the limb; they are made by transfixion where the position of the bones in the limb will admit of it, and in this case they are cut from the centre of the part towards the circumference. When the bones do not occupy a central position in a limb, one of the flaps is generally formed by cutting from the circumference to the centre. Recently a modification of the ordinary double flap operation has been introduced by Mr. Teale, and to this we shall subsequently refer more at length. The flap operation is quickly and easily performed, and generally gives satisfactory results; but in the thick part of a muscular limb the size of the external

wound is somewhat excessive, and in certain parts there is a risk of splitting up the large vessels instead of dividing them transversely.

(3.) There exists a mode of amputating by a combination of the two methods first alluded to; it consists in forming double flaps of integument, and subsequently dividing the muscles down to the bone as in the circular amputation. It is strongly recommended by many surgeons, and deservedly so, for this plan of dividing the integuments facilitates their reflection: while the circular division of the muscles ensures a completely transverse section of the vessels; thus it combines many of the advantages of both the circular and the flap operation.

(4.) *The oval incision* is principally used for the removal of the fingers and toes at their various articulations, and occasionally for amputation at the shoulder joint. It is effected by dividing all the soft parts surrounding the bone in the direction indicated by its name.

Mr. Teale calls his operation "*amputation by a long and a short rectangular flap.*"

The long flap, which is anterior or antero-external, is quadrangular in shape, its length and breadth being each equal to half the circumference of the limb. It includes all the soft parts down to the bone on the anterior aspect of the part, and should not contain any important nerve or blood-vessel. The short flap is posterior, or postero-internal; it is one-fourth the length of the anterior, and its breadth is equal to half the circumference of the limb. It includes all the soft parts down to the bone on the posterior aspect of the limb, and *should* contain the large nerves and blood-vessels of the part. Both flaps are flat at their extremities and of the same thickness throughout, where the arrangement of the soft parts about the bone will permit. Mr. Teale claims for this plan of operation

(1) a freedom from tension in the stump; (2) a soft covering for the ends of the bones, free from large vessels and nerves; and (3) a dependent position of the wound, favouring the escape of its secretions.

The operator should be provided with an amputating knife about seven inches long in the blade and pointed at its extremity, two narrow scalpels of different lengths, a catlin, a strong-backed narrow knife with a blade five inches in length for amputations about the carpus and tarsus, a pair of bone nippers, and an ordinary saw; and, lastly, let him, if possible, secure the services of an assistant who may in these, as in other, operations learn *his* duty, which, in its degree, is no less important than that of the operator.

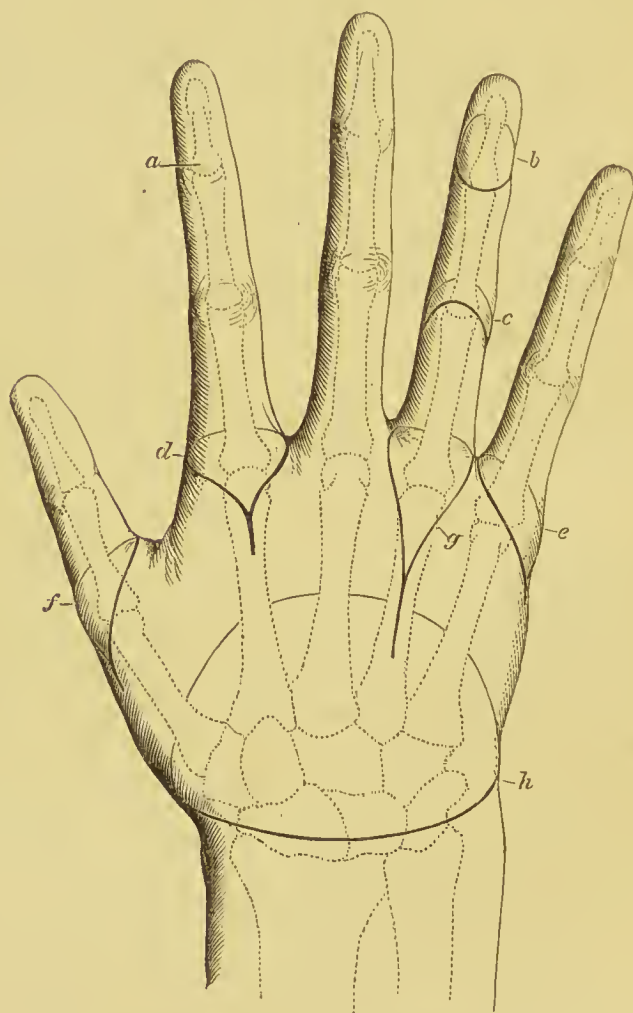
If there be any scarcity of subjects, the incisions that have been made in ligaturing the arteries should be sewn up, and the same body used for the practice of the amputations.

Amputation of the phalanges of the fingers by disarticulation.—Before commencing these operations, it will be well to take a general view of the skeleton of the hand, and to entertain some considerations as to the exact positions of the phalangeal joints, and the shape of the articular extremities of the phalanges.

Situation of the articulations.—Let the operator close his hand and inspect the back of it, comparing it with the bones in the accompanying woodcut. He will observe that the prominences of all the knuckles—we mean those of all three rows—belong to the proximal bones of the respective articulations; that is, that the first row of knuckles is formed by the heads of the metacarpal bones; the second row, by the extremities of the first phalanges; and the third, by those of the second phalanges. Thus it follows, that the line of articulation in each case is just *beyond* the

corresponding knuckle. Having noticed the situation of the articulations, we would recommend the operator to observe their precise shape; and for this we would refer him to fig. 13, where he will find the line of the two more

Fig. 13.



distant phalangeal joints to be concave from side to side, with the concavity directed towards the ends of the fingers. He may also notice that the line of articulation runs parallel to and is the same shape as the inferior margin of the nail

where it first appears from the matrix. A semilunar incision in this direction, and in front of the corresponding knuckle, will therefore lay open any of these phalangeal joints in their entire width.

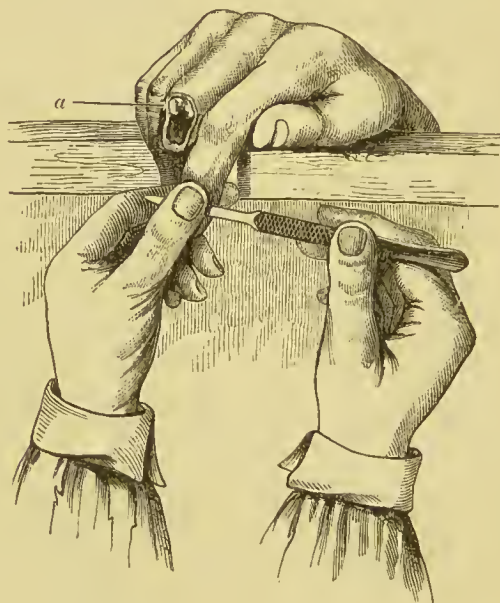
The metacarpal joints of the phalanges are curved in the opposite direction, that is, their concavity points towards the wrist; the line of their articulation lies just in front of the first row of knuckles, and fully half an inch behind the clefts of the fingers, as these are seen from the palm.

There are many methods of amputating the phalanges of the fingers, and while some are much more easy of execution than others, it is advisable to practise all; for on the living body we rarely have a choice of plan for operating, but must rather adapt our method to the necessities of the case and the condition of the soft parts around the bones. The most common proceeding adopted for removing either of the more distal phalanges is by disarticulation, and if by this means the covering for the remaining bone is insufficient, to complete the operation by removing its head with the bone forceps.

Disarticulation of the distal phalanx of the fingers or thumb by a single palmar flap.—The operator being prepared with the smaller of the two scalpels, which should be sharp-pointed and narrow, should stand facing the dorsum of the hand with the fingers pointing towards him; let him grasp the last phalanx between the forefinger and thumb of the left hand (fig. 14), the thumb being placed uppermost. The scalpel, held as a pen, with its cutting edge turned towards the operator, must now be thrust through the soft parts immediately beneath the shaft of the phalanx, just anterior to the bony tubercle (fig. 13 a), that may be felt on its under side: this is situate just in front of the joint, and marks the spot where the shaft of the phalanx expands into the articular extremity. A flap should

now be formed from the under surface of the finger about two thirds the length of the last phalanx. Lastly, connect the opposite angles of the flap by a curved incision made on the back of the articulation in such a direction, as will open the joint in its entire width (fig. 13 *b*): divide the lateral ligaments, at the same time bending the joint,

Fig. 14.



and the operation will be complete. It will be found that the convexity of the flap will just adapt itself to the concavity of the incision on the back of the finger. Fig. 14 *a* represents the appearance of the wound after the performance of this operation.

The same operation may be performed for the removal of the fingers at their second joints, and the directions that we have given above will apply throughout.

There is another method of amputating by a palmar flap,

which is also applicable, both to the second and last phalanges of the fingers. The operator should grasp the phalanx to be removed between his finger and thumb, and forcibly bending it, let him cut into the back of the joint in its whole extent, divide the lateral ligaments, and passing the knife beneath the bone, complete the operation by cutting a flap of sufficient size from the palmar surface of the finger: the wound in this case should be precisely the same shape as in the preceding operation.

It often happens in practice that the integuments on the palmar side of the finger are insufficient of themselves to form a covering for the head of the remaining bone; in these cases either the head of the proximal phalanx may be removed with the forceps, or a small flap must be traced out and reflected from over the back of the joint.

Amputation of the phalanges of the fingers by double flaps. — The hand being placed in a position of pronation, the operator stands as in the preceding operations; he should transfix the soft parts immediately under the shaft of the phalanx, just in front of the joint at which he wishes to disarticulate, and thus cut a short flap from the palmar side of the finger. A semilunar flap of the same dimensions being traced out over the dorsum of the joint, should be reflected, the joint opened from behind, and the bone removed. Fig. 13 *c* shows the shape and position of the flaps for this operation.

Amputation of the first, second, and third fingers at their metacarpal joints. — The operator, having taken in hand the larger of the two scalpels with which he is supposed to be provided, should stand grasping the finger he is about to amputate and facing the subject; while the assistant, standing with his back turned towards the subject, should separate the contiguous fingers. The hand being pronated, let an incision be commenced on the back of the

metacarpal bone, about half an inch behind its head ; this must be carried along the line of the extensor tendon for half an inch, and then diverge to the operator's right hand side, and run obliquely up to the angle of the cleft between the fingers, pass across the palmar surface of the first phalanx, at the transverse mark which is found at its base, and returning to the back of the hand, should fall into the first incision just over the prominence of the knuckle (fig. 13 *d*). This cut should extend down to the bones in its whole extent, and if possible should divide the extensor tendon of the finger as it lies on the head of the metacarpal bone ; the incision may be a continuous one, or more easily it is formed by making two separate cuts, each commencing on the back of the metacarpal bone and joining on the palmar surface of the first phalanx. The soft parts must be dissected from the posterior part of the joint, the lateral ligaments divided, while the operator puts them on the stretch, and the articulation opened by a semilunar incision with its convexity directed towards the ends of the fingers ; the remaining ligamentous connections of the bone being severed, the operation will be complete. In practice, should there be insufficient integument on the finger to cover the head of the metacarpal bone, the same operation may be performed, and the head of that bone removed with the cutting forceps, applied so as to divide the bone obliquely.

Amputation of the little finger at its metacarpal joint.—For this, the same operation may be put in practice, except that the angle of the incision should fall over the ulnar side of the corresponding metacarpal bone (fig. 13 *e*).

*Amputation of the fingers en masse at their metacarpal joints.**—The operator, standing as in the preceding opera-

* The operation is here described as it should be performed on the left hand.

tions, should turn up the palm of the hand as is represented in fig. 17, p. 76, and trace a convex flap, commencing and ending on the distal extremities of the metacarpal bones of the little and index fingers respectively, and extending towards the fingers as far as the transverse line seen on the palmar aspect at their roots. Turning the fingers in the opposite direction, so as to bend the knuckles and expose the back of the hand, let him make an incision commencing and ending at the extremities of the second and fifth metacarpal bones, and extending over the knuckles as far as the fork of the fingers, as seen on their dorsal aspect, thus forming a semilunar flap with its convexity turned towards the fingers and reaching just beyond the heads of the metacarpal bones (fig. 15, p. 73). Having reflected this, and opened all their joints on the dorsal aspect, let the operator completely divide the capsular ligaments, and pass the blade of the knife behind the heads of the phalanges he is about to remove; and by cutting towards the fingers, he will bring the knife out in the palm at the extremity of the flap which he first traced.

Amputation through the third and fourth metacarpal bones.—This operation, though demanded in many cases of injury, is often employed in preference to the removal of the fingers at their metacarpal joints, in those cases where the appearance of the hand is a more important consideration than its strength. An incision, such as is represented in fig. 13 *g*, being made so that its angle is on the dorsum of the metacarpal bone, midway between its articular extremities; the integuments should be dissected from the shaft and head, proceeding from behind forwards, until the palmar surface of the bone is nearly cleared: the knife should now be thrust under the bone, and made to free its anterior surface from any remaining connections. This accomplished, the shaft of the bone should be divided

obliquely with the bone forceps, so as not to leave an abrupt extremity. The foregoing operation has an advantage over the one more commonly employed, in not leaving behind it any cicatrix in the palm, and in injuring no bloodvessels of any size. The position of the operator and assistant should be the same as in amputation of a finger at its metacarpal joint: a long narrow scalpel should be used.

Amputation through the second and fifth metacarpal bones.

— These bones may be removed with greater facility than the two last mentioned, and the same operation may be used, except that the incisions must commence and end on the radial side of the second, and on the ulnar side of the fifth metacarpal bone. In using the forceps it is here especially necessary to divide the bone obliquely, and thus avoid an unsightly prominence on the side of the palm. No artery of any consequence need be wounded in any of the preceding operations; though care must be taken, in separating the second metacarpal bone from its connections, to avoid injuring the arteria radialis indicis, anywhere but at the point where it *must* be divided, namely, opposite the metacarpo-phalangeal articulation.

Amputation of the thumb at its metacarpo-phalangeal articulation. — It may save subsequent trouble and much facilitate the process of disarticulation, if the operator will turn to page 73, *fig.* 15, and glance at the skeleton of the hand. He will notice that the line of this articulation is much more nearly transverse than that of the same joint in the other fingers; it is situated just in front of the prominence of the knuckle, and for practical purposes may be considered to run straight across the thumb from side to side. To remove the thumb at this joint, make an incision as represented in *fig.* 15 *b*, with its angle on the subcutaneous surface of the metacarpal bone half an inch behind the head, and passing in front of the thumb just

beyond the sesamoid bones. Dissect away the soft parts from the back and outer side of the joint, and open it on its posterior aspect, twisting the thumb hither and thither to facilitate the division of its ligaments. In separating the soft parts from the front of the phalanx, care should be taken lest the point of the knife be entangled in the sesamoid bones, for covering which a larger provision of soft parts must be made than was necessary in the corresponding operation on the other fingers.

Amputation of the thumb at its articulation with the trapezium.—It will be well to examine this articulation before attempting to remove the bone. The articular surface of the trapezium is saddle-shaped, and so indeed is the metacarpal bone of the thumb, though in an opposite direction, and thus it is by no means easy to insinuate the point of the knife between their opposed surfaces; the exact position of the joint may, however, be ascertained by passing the forefinger down the dorsal surface of the corresponding metacarpal bone towards the wrist, until the tubercle is felt at the base of the bone which gives insertion to the extensor ossis metacarpi pollicis; immediately behind this point of bone lies the articulation in question. The operator should grasp the thumb, and stand facing the dorsum of the hand, which should be in a position between pronation and supination; the fingers should be held aside by the assistant. The point of a narrow knife must be inserted midway between the tubercle of bone above alluded to and the styloid process of the radius, and an incision be carried from this spot obliquely along the dorsum of the metacarpal bone to the ulnar side of the base of the first phalanx of the thumb *, around the palmar surface of which it must pass

* In operating on the right side of the body, the incision would of course be made in the opposite direction.

transversely and be carried down the radial side of the metacarpal bone, to the point from which it started. The soft parts should be dissected from the back and sides of the bone until the knife can be passed under its shaft, along the palmar surface of which it should be drawn until it cuts its way out at the transverse part of the first incision, on the palmar surface of the first phalanx. The articulation of the metacarpal bone with the trapezium may now be opened, and the ligaments divided while the bone is twisted here and there, to put them on the stretch. In performing this operation, some difficulty will be experienced in carrying the knife along the palmar surface of the metacarpal bone without either getting the blade locked between the sesamoid bones and the head of the metacarpal bone, or wounding the skin over the prominence of those bones; to avoid this, the knife should be held with a light hand, and its edge be turned to allow of its passing over the top of these bones, which of course are removed in the operation.

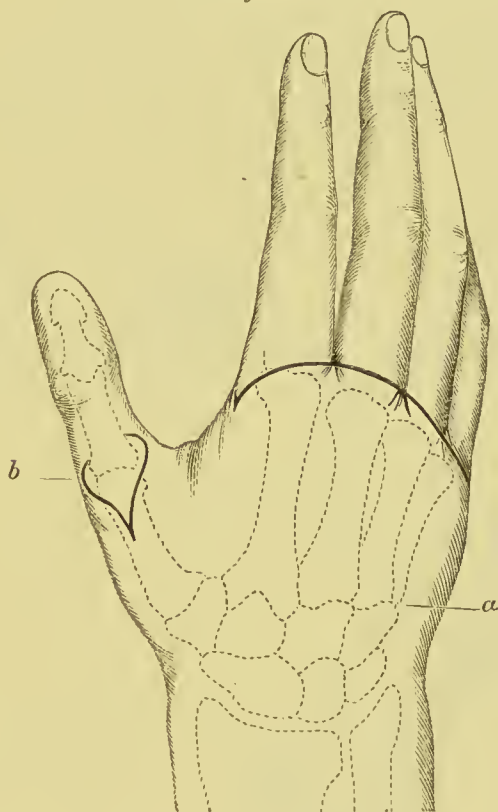
Amputation of the hand at the carpo-metacarpal articulation, leaving the thumb and its long muscles intact.—This operation has been most successfully adopted as a substitute for amputation of the whole hand in gun accidents and lacerations by machinery, where, as often happens, the thumb is not involved in the general injury to the parts.*

The operator should glance at the articulations he is about to open; it is marked *a* in fig. 15; it is formed by the four inner metacarpal bones and the second row of carpal bones. He will observe on the dorsal surface that the three metacarpal bones on the ulnar side, form with the os magnum and unciform bones, a pretty regular series

* See "Medical Times and Gazette," Oct. 30th, 1858, for an account of this operation on the living body.

of joints, slightly curved, with the convexity towards the fingers; while the articulation between the head of the second metacarpal bone on the one hand, and the tra-

Fig. 15.

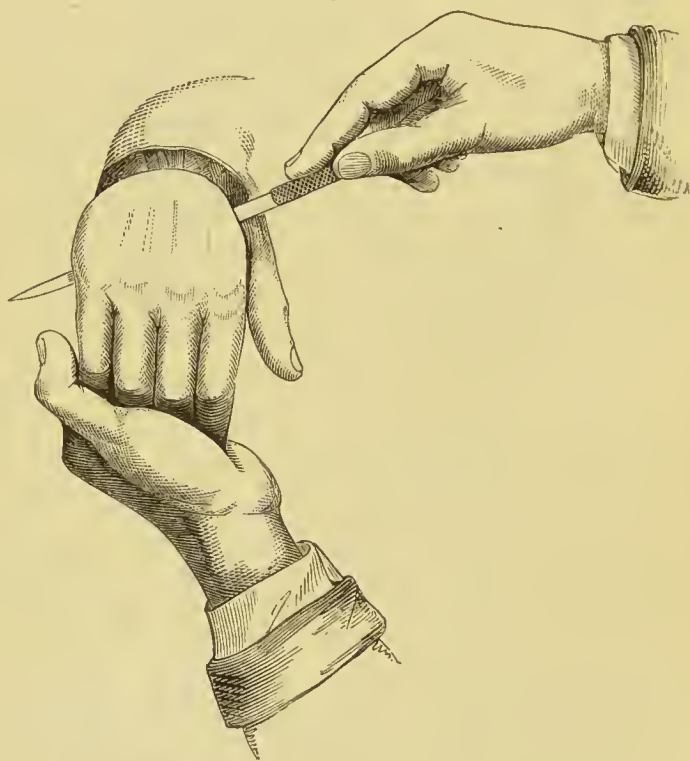


pezium, trapezoid, and os magnum on the other, is much more irregular, nor is this irregularity exactly uniform in all bodies.* That part of the articulation now in question may be roughly compared in its outline to the letter **W**, the open part of the letter being directed towards the

* In ten articulated skeletons we have examined there are no two exactly similar in this particular. We have described that outline of articulation which appears most prevalent.

fingers. The general direction of the series of joints is pretty accurately ascertained in the living or dead body, by gliding the fore-finger and thumb of the left hand down the sides of the fifth and second metacarpal bones respectively, towards the wrist, until arrested on either side by a prominent tubercle at the base of each bone. A line drawn across the wrist, from a point immediately behind one of these tubercles, to a similar point behind the other,

Fig. 16.



indicates sufficiently accurately the line of the articulations.

The operator having furnished himself with a sharp-pointed, strong, and narrow knife, such as is used for operations on the tarsus, should take his place looking towards the forearm, while the assistant faces him, sup-

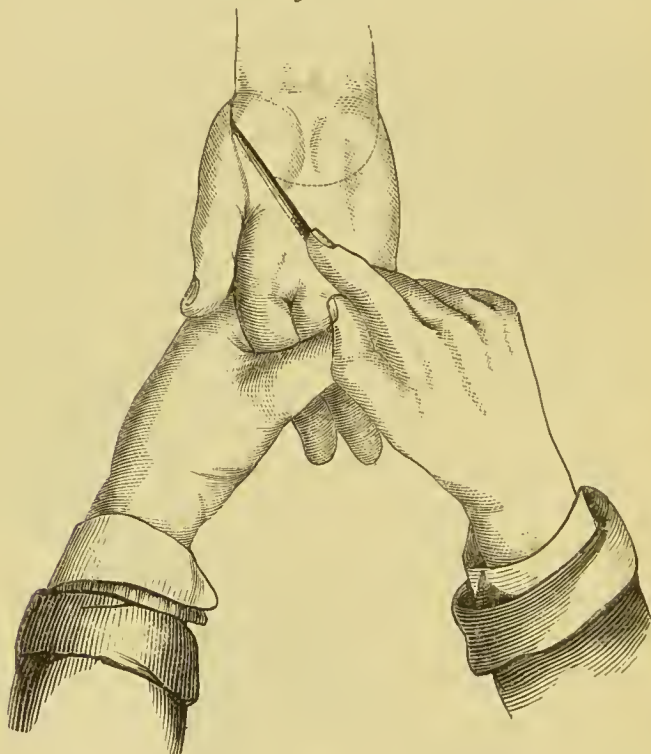
porting the wrist; placing his forefinger and thumb upon the carpal extremities of the fifth and second metacarpal bones, let the operator thrust the knife through the palm from side to side, as near the shafts of the metacarpal as possible, its points of entrance and exit being just in front of one and the other of the aforesaid tubercles; in this manner a flap can be cut from the palm of the hand, about two or three inches in length (fig. 16). An incision should now be made across the back of the wrist, joining the angles of the flap just formed and anterior to the line of the carpo-metacarpal articulation.* The operator, grasping the hand, and strongly flexing the wrist, should commence by opening the articulations on the ulnar side, dividing the dorsal ligaments with the point of his knife; this he will succeed in effecting until arrested by the first prominence at the base of the second metacarpal bone, around *this* he must turn, cutting with the point of his knife; and so again around the second projection of the same bone, until he has opened the articulation in its entire width. This once effected, he has only to complete the separation of the bones, and pass the knife behind them into the palm, and the operation is concluded. The radial and ulnar arteries will be divided in this operation, in that part of their course where they extend into the palm of the hand; their cut ends should be sought in the palmar flap.

Amputation of the hand at the wrist joint by a palmar flap. — The articulation formed between the radius and fibro-cartilage on the one hand, and the scaphoid, semilunar, and cuneiform bones on the other, is curved in its direction from side to side, having the convexity of the curve directed towards the forearm (fig. 15). Its position can easily be ascertained by feeling for the styloid processes of the radius and ulna, between which points of the bone the line

* This incision is shown in fig. 16 as already made.

of the articulation extends in the direction above indicated. A knife should be used such as was employed in the preceding operation. The operator facing the forearm of the subject, and having ascertained the exact position of the styloid processes of the radius and ulna, should grasp the hand as represented in the adjoining woodcut (fig. 17), and trace a semilunar flap from the palm, commencing (for

Fig. 17.



the right hand) at the apex of the styloid process of the radius, and terminating at the same point on the ulna : this cut should reach to the bones in its whole extent. An incision should now be made across the back of the wrist from one styloid process to the other, connecting the angles of the flap*, the soft parts divided and the wrist joint opened ;

* Fig. 13 *h*, page 64.

the lateral ligament to the operator's left-hand side being *first* divided with the point of the knife, the opposite one may be subsequently disposed of; the carpal bones being separated from their ligamentous connections, the heel of the knife should be laid beneath them and be carried with a sawing movement away from the wrist, under the metacarpus, until it cuts its way out at the extremity of the flap that has been traced in the palm. The radial and ulnar arteries will both be divided in the foregoing operation, and their divided ends will be found at the angles of the palmar flap.

The convexity of the flap formed in this method, will be found to accommodate itself to the slight concavity of the incision on the back of the wrist; while the general adaptation of the parts will be completed by the removal of the styloid processes of the radius and ulna with the bone forceps.

Amputation of the hand at the wrist joint by double flaps.

— This operation may be performed in the same manner as the preceding, excepting that the anterior flap cut from the palm must be of smaller dimensions; while one of the same size as this must be cut from the back of the wrist and reflected, the operation being completed as in the last described method. Where there is an opportunity for choice on the living body, we venture to recommend the amputation by a single flap, as it gives a firmer and better nourished covering for the bones than that by double flaps.

Amputation of the forearm.—(a) by the circular method; (b) by double flaps; (c) integumental flaps and circular division of the muscles; (d) Mr. Teale's method.

(a) In amputating by the circular operation, the operator should stand outside the limb which he is about to remove, the arm being extended from the side of the body, and being placed in a position midway between pronation and

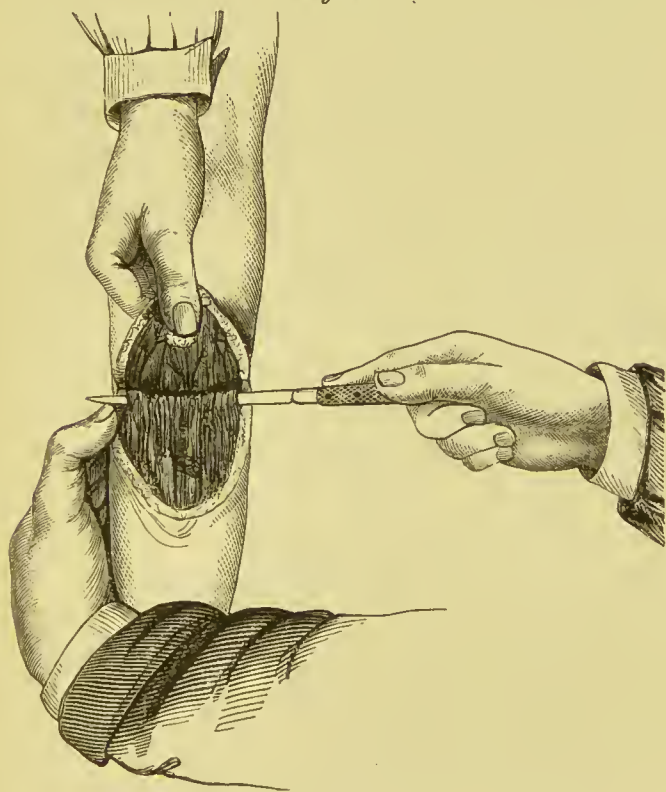
supination. A small amputating knife about six inches long in the blade, should be used. The assistant, standing on the opposite side of the forearm, should surround the part with his hands and retract the skin forcibly. Grasping the knife in his fist* with its edge turned upwards, and placing the right foot slightly in advance, let the operator stoop down and pass the knife beneath, then above and thus around the limb, dropping its point until it is as nearly vertical as possible, its back being turned towards him and its heel resting against that part of the arm nearest to himself. From this point let him commence a circular incision of the integument alone, raising his body to the erect position as he does so, and making his knife retrace its steps until the skin in the whole circumference of the limb is divided. The integument being retracted should be dissected back and turned over on itself, until about two inches or more have been reflected. Let the operator divide the muscles close to the reflected integument, in the same manner as the skin and subcutaneous tissue, the assistant still continuing to retract the parts. Thrusting the knife through the interosseous membrane, and having cleared the bones for the application of the saw as high as possible, the saw should be laid across the bones with its heel resting on either one of them, and should first be *drawn towards* the operator while it is pressed pretty firmly against the bones. This will make such a notch as will prevent it subsequently slipping from the part to which it was first applied.

The radial and ulnar arteries will be found in the anterior part of the stump, in front of the bones from which they respectively derive their names; the anterior and posterior interosseous vessels may be sought for, in close connection with the membrane, midway between the bones.

* Fig. 5, p. 6.

(b) *Double-flap amputation of the forearm.*—Before undertaking this operation it may be well to notice the abundance of soft parts on the front of the forearm, and the comparatively bare condition of the bones posteriorly. The forearm should be supported horizontally, away from the body and supine, as in this latter position the bones are more nearly parallel and in the same horizontal plane with each other. The operator should stand outside the

Fig. 18.



limb, if it be that of the right side, and inside that of the left; the assistant opposite to him on the other side of the forearm. The soft parts over the front of the limb being grasped and slightly upraised by the operator's left hand, let him

transfix the limb from side to side immediately in front of the bones, entering the knife at the subcutaneous margin of the nearer bone, and coming out at the corresponding spot on the opposite side of the forearm. Now cutting downwards towards the wrist, a flap should be formed with a rounded border about three inches in length; this may be held up, but not retracted, by the assistant. Seizing the soft parts on the back of the forearm, let the operator draw them away from the bones and again transfix the limb, immediately behind the bones, the points of entrance and exit of the knife being respectively the nearer and more distant angle of his first incision; in this manner a posterior flap may be formed, which should be rather longer than the anterior. In performing the second transfixion of the limb, it is often difficult to avoid wounding the skin on the distal side of the forearm, and to insure its safety it is better to hold down its cut edge with the thumb during the passage of the knife, in the manner represented in the preceding woodcut (fig. 18). The soft parts being retracted by the assistant, the knife should be passed around and thrust between the bones both in front and behind, just at the angle of junction of the flaps, at which point the saw should be applied. It is the custom with some operators to recommend that the bones should be divided while in a position midway between pronation and supination, to insure their being left more nearly the same length; there is no objection to this proceeding. The position of the divided ends of the radial, ulnar, and interosseous arteries has been alluded to, in the description of the preceding operation.

(c) *Amputation by integumental flaps and a circular division of the muscles.* — The position of the limb, operator, and assistant being the same as in the preceding operation, a semioval flap, composed of integuments alone, should be cut and reflected from the front of the forearm, beginning

at the more distant side and ending on that nearer to the operator; the flap should be about three inches in length, and should occupy exactly half the circumference of the limb. The forearm being slightly bent, a similar flap should be cut and reflected from its posterior surface, commencing and ending at the same points as the anterior; the parts being retracted by the assistant, the muscles may be divided in a circular manner, close to the base of the flaps, and the operation completed as in other amputations of the forearm.

(*d*) *Amputation of the forearm by Mr. Teale's method.* — General directions for performing this operation will be found at page 62. The arm being in the prone position, the operator, standing on the right-hand side of the limb*, must trace with a short amputating knife or long scalpel, the lateral incisions of the anterior long flap, along the subcutaneous margins of the radius and ulna respectively, dividing the integuments alone: the transverse incision of the same flap may be made at one sweep of the knife, dividing everything down to the bones; all the soft parts in front of these and the interosseous membrane being reflected upwards, the posterior or short flap may be cut in the same way, and being reflected as high as the commencement of the lateral incisions of the long flap, the bones may be sawn. For the appearance of the flaps, and the manner of bringing the parts together after the operation, we refer the operator to fig. 30, and fig. 31, pages 106, and 107.

Amputation of the upper arm may be effected (*a*) by the circular operation; (*b*) by double flaps; (*c*) by integumental flaps and circular incision of the muscles; (*d*) by Mr. Teale's operation.

(*a*) For this proceeding the operator should be provided with an ordinary amputating knife and saw; he should

* The patient's right-hand side, *i. e.* outside the right arm, inside the left.

take his place outside the limb he is about to remove, while the assistant should stand at the shoulder of the subject. The arm being extended from the side, the assistant should encircle it just below the point at which it is to come off with both hands, and retract the integuments to their utmost. The operator bending both knees, should stoop down and pass his knife around the limb from its under side, and laying the heel of the blade on the side of the arm nearest to him, should make a circular sweep around the limb, at the same time straightening his own body, and rising to the erect position. This cut should divide the integuments down to the muscles, which must be bared of their covering to the extent of two or three inches, by dissecting off the skin and subcutaneous tissue; the assistant meantime turning back the parts while he retracts them. The muscles and all the remaining soft parts down to the bone should now be divided by a circular sweep of the knife, effected in the same manner as the incision of the integuments, the edge of the knife being laid close against the reflected integument. Let the assistant again grasp the muscles and integuments *en masse*, and retract them; the stump will now assume a conical form, and the operator should again sweep his knife around the bone; dividing this muscular cone about its centre, and applying the saw at the same spot, the operation will be complete.* The divided ends of the brachial, the superior and inferior profunda arteries, should be sought and recognised if possible, in the stump.

(b) In the amputation by double flaps the arm should be rotated outwards, the assistant and operator being placed as in the preceding method. Having with the left hand

* In sawing the bone, the operator should grasp it with his left hand just below the point of section; in this way only, will he effectually steady it.

grasped and raised the soft parts in front of the humerus, let the operator transfix them, the point of his knife grazing the anterior surface of the bone in its passage through the limb, and passing in front of the brachial vessels; a semilunar flap should be formed about three inches in length, as the knife cuts its way out. The operator should now grasp the soft parts on the posterior aspect of the limb, draw them away from the bone, and transfix them, cutting a posterior flap about the same size and shape as the anterior; sweeping the edge of the knife around the bone to clear it from any remaining connections, the saw should be applied as high up as possible, while the assistant retracts both flaps. The brachial artery should be looked for near the inner angle of junction between the anterior and posterior flap.

(c) To remove the upper arm by integumental flaps and by a circular division of the muscles, the operator should procure a short amputating knife, and should take his place outside the limb of the right side, inside that of the left, the arm being carried out from the side. Commencing on the side of the limb farthest from him, he should trace out in the skin and subcutaneous tissue a flap with its convexity downwards, and again, passing his hand under the limb, he should connect the opposite angles of the first incision by tracing a flap of the same size and shape on the posterior surface of the limb; these being retracted by the assistant, and reflected from their deep attachments to the fullest extent, the muscles should be divided at their base, as in the circular operation, and the bone sawn through as high up as possible.

For a description of Mr. Teale's method of amputating, we refer the reader to the general description of his plan of operating, at page 62, and to fig. 30, and fig. 31, page 107. In the upper arm the anterior flap should be made rather

external in position, and care should be taken to include the brachial vessels in the posterior or short flap.

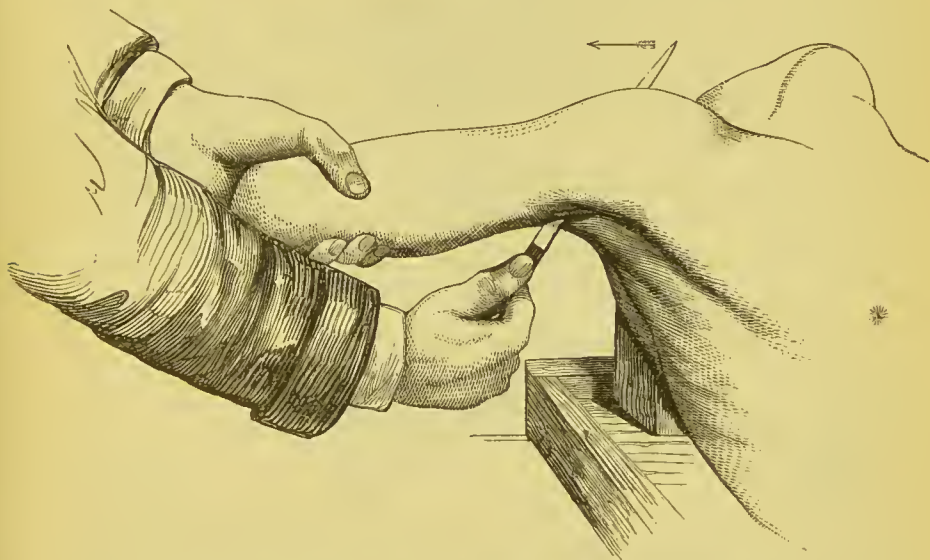
Amputation of the arm at the shoulder-joint. — The plans adopted for disarticulating the humerus at this joint are very numerous, though many only differ from each other in inessential particulars. We shall only describe (*a*) the operation by an upper and a lower flap; and (*b*) that by an anterior and posterior flap.

(*a*) The body, being raised by two or three blocks placed beneath the shoulders, should be brought towards the edge of the table, the operator should stand outside the limb, and the assistant behind the shoulder. In this as in all operations for disarticulation at the shoulder-joint, an amputating knife of moderate dimensions will be found more commodious than the formidable weapon generally figured in books. The operator grasping the deltoid in his left hand, and raising it, should thrust his knife beneath it, transfixing the limb just below the acromion, and on its upper and outer aspect; the knife should graze the neck of the humerus, and in cutting its way out below should form a flap with a rounded border, about four inches in length; this the assistant raises and retracts. The head of the bone being now exposed, the heel of the knife should be laid on the upper aspect of the anatomical neck, and the muscles inserted into the greater tuberosity divided, while the bone is rotated inwards; the joint being opened on its upper and outer aspect, the subscapularis should be divided, the knife passed behind the neck of the bone, and with one sweep be made to cut its way out in the axilla, forming an inferior flap similar to the first. In the living body the axillary artery should be controlled by pressure made against the first rib just external to the scalenus anticus; after the operation, its divided end will be found near the inner angle of junction between the

flaps. The preceding operation is modified by some surgeons, in that the anterior flap is cut and reflected, instead of being formed by transfixion.

(b) *Disarticulation by anterior and posterior flaps.*—The subject and assistant being placed as in the preceding operation, the operator, standing on the outside of the limb near the elbow, should grasp the shaft of the humerus low down, draw the arm out from the side, and at the same time throw the head of the bone forwards; he should insert the knife with its edge turned towards him, just in front of the

Fig. 19.



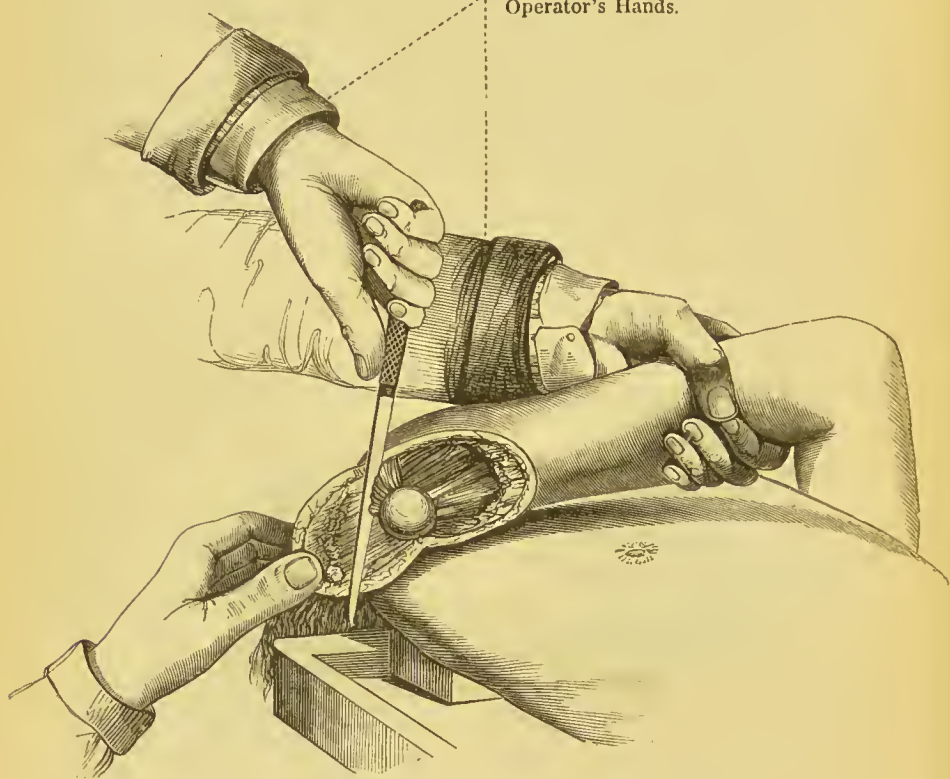
The arrow represents the direction in which the flap should be cut.

posterior fold of the axilla, and thrusting it upwards, close *behind* the neck of the humerus, should bring out its point as near the acromion as possible; the accompanying woodcut (fig. 19) shows the knife in its proper position, and the manner in which the humerus should be held. A flap should thus be cut from the posterior aspect of the limb, about four inches long, and oval at its extremity, this the assistant should grasp and keep it well retracted. The

arm should now be thrown forwards across the chest (fig. 20), and the heel of the knife applied to the head of the bone to divide the three muscles of the greater tuberosity ;

Fig. 20.

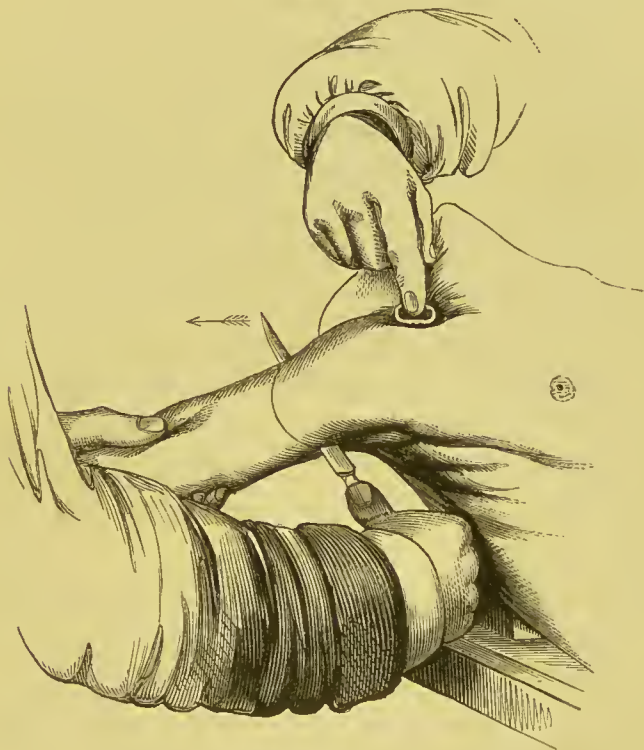
Operator's Hands.



this will thoroughly open the joint on its posterior aspect, and will enable the operator to complete the division of the capsular ligament, to pass the knife from behind forwards, between the head of the bone and the glenoid cavity, and to divide the tendon of the subscapularis. Having now passed the knife round the head of the humerus, so that its blade rests against the front of the neck of the bone, the arm should be placed in the position shown in (fig. 21), and the operation completed by forming a flap — such as

is there represented by a dotted line. The axillary artery will be found in this, the anterior flap, near its extremity, and it is, as it should be in all cases, nearly the last thing divided in this method of disarticulation.

Fig. 21.



Before proceeding to the amputations of the lower extremity it is advisable to perform the amputation of the breast, if the sex of the subject admits of the operation being practised with any advantage.

Amputation of the breast.—The main object in this operation is to leave sufficient integuments and soft parts to cover, without stretching, the wound inflicted by the removal of the gland. A large scalpel is the only instrument required for this operation on the dead body; it should be held as a pen if the breast is small, if voluminous, it may be grasped

more firmly in the second or third position (p. 4). The operator should stand on the same side of the body as that of the breast to be removed, the corresponding arm of the subject being carried out from the side; he should make two semi-elliptical incisions, having their long axes parallel with that of the ribs, and including between them, the nipple and a sufficiency of skin to allow of the removal of the gland through the wound. These incisions should meet one another beyond the axillary and sternal borders of the breast respectively. For the right breast the upper incision should be first made, commencing from the axilla; it should extend pretty deeply into the subcutaneous fat; it should not cut quite vertically through the skin, but rather in an upward direction, so as to pass over the convex surface of the breast without injuring the glandular structure. The lower incision should next be made from the sternum towards the axilla, and this also should be adapted somewhat to the convexity of the breast. While the assistant grasps the gland and draws it upwards, the operator should seize the skin at the lower edge of the wound and dissect it off the breast until the lower border of the gland comes into view; lifting up this and dissecting between it and the pectoral muscle, he must *completely* undermine the gland. Taking the breast into his own hand, and drawing it downwards while the assistant raises the upper edge of the wound, the operator should dissect away the coverings from the upper part of the gland until he reaches its upper boundary, when the separation of the breast will be complete, and the operation concluded.

CHAP. VII.

AMPUTATIONS OF THE LOWER EXTREMITY.—AMPUTATION OF THE PENIS.—EXCISION OF THE TESTICLE.

Amputations of the Lower Extremity.—General Remarks on the Skeleton of the Foot, and the Position of its various Articulations.—Amputation of Phalanges of Toes.—Ditto of Toes *en masse*.—Lisfranc's Amputation.—Chopart's.—Syme's.—Operation of M. Roux.—Pirogoff's Amputation.—Ordinary method.—Dr. Eben Watson's method.—Amputations of the Leg: (1) circular, (2) flap, (3) combined method, (4) Teale's operation.—At the Knee Joint, by (1) anterior flap, (2) by posterior flap.—Amputation of the Thigh: (1) circular, (2) flap, (3) combined method, (4) Teale's operation.—Amputation at the Hip Joint.—Removal of Penis.—Excision of Testicle.

FOR the successful performance of the amputations about the tarsus a knowledge of the outline and exact position of its various articulations is so essentially necessary, that we make no apology for here introducing a few remarks on what may be called the external anatomy of the part, and for appending a sketch of the foot with an outline tracing of its bones. By attending to a few simple rules, the position of the various joints of the tarsus may be exactly ascertained, at any rate, when they have not previously been the seat of disease.

As was the case in the hand, the two distal phalangeal joints of all the toes, with the exception of the first joint of the great toe, are concave from side to side, the concavity being directed towards the ends of the toes, and they are all situated about two lines in front of the corresponding knuckles; the prominence of the knuckle belonging in

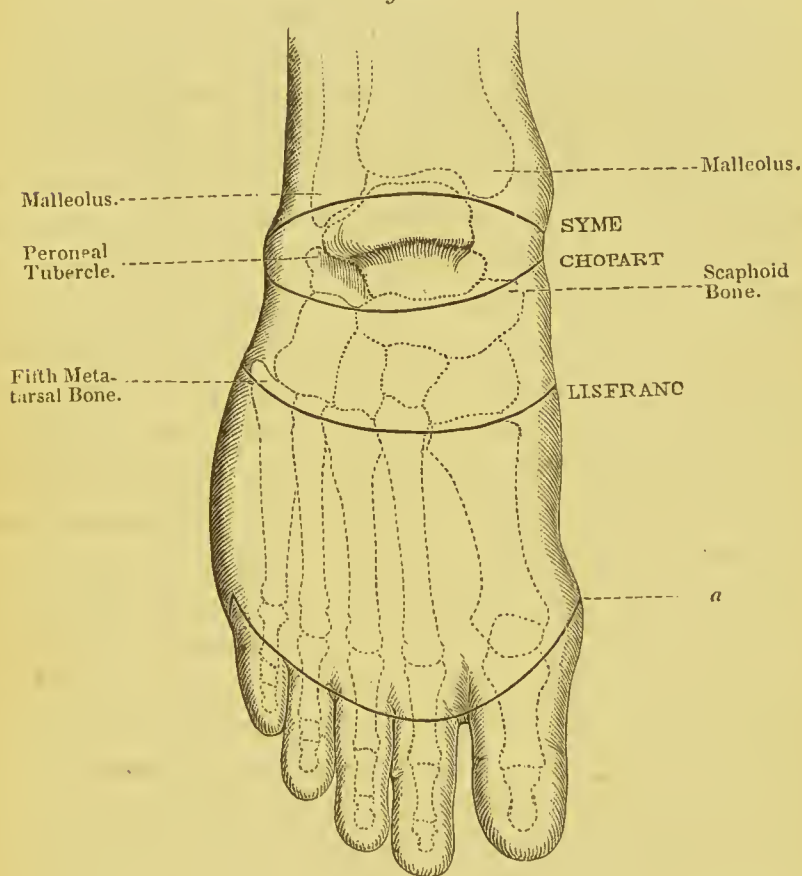
every case to the nearer of the two bones entering into its formation. The first, or metatarsal articulation of the phalanges of *all* the toes, is concave in its outline from side to side, with its concavity turned towards the tarsus; it lies just in front of the heads of the corresponding metatarsal bones, which latter can be plainly distinguished in any foot.

To ascertain the situation of the tarsal articulations, the operator, pulling the right foot over the edge of the table, and facing the body (turning his attention to the inner side of the foot), should place the forefinger of his right hand on the inner malleolus, and draw the point of the finger down the inner side of the foot. His attention will first be arrested by the tubercle of the scaphoid bone (fig. 22), which here forms a marked prominence, exceedingly useful as a guide, firstly to the articulation between it and the astragalus, opened in Chopart's amputation; and secondly, to its joint with the internal cuneiform bone; the latter of these articulations is situated half an inch in front of the prominence, the former lies a quarter of an inch behind it. Tracing onwards along the inner border of the foot, the projection of the proximal end of the first metatarsal bone may perhaps be distinguished, indicating the situation of the joint between that bone and the inner cuneiform, opened in performing Lisfranc's operation. But a more sure guide to the situation of this joint is afforded, by considering that it lies an inch and a half in front of the tubercle of the scaphoid bone (fig. 22), the latter point being easy of recognition.

Turning now to the other side of the foot, let the operator place the forefinger of the left hand on the outer malleolus, and trace along the outer border of the tarsus; here he will meet with two prominences, both deserving of attention. The first, a small, but sharply defined point of bone on the

os calcis, about an inch below the malleolus, and generally called the peroneal tubercle (fig. 22); from an inch to an inch and a half farther on, he will encounter a well marked bony prominence, constituting the proximal end of the

Fig. 22.



metatarsal bone of the little toe (fig. 22). The articulation between the calcis and cuboid is situated about half an inch in front of the peroneal tubercle, or it may be said to be midway between that point and the prominence of the fifth metatarsal bone.

The joint between the cuboid and fifth metatarsal bone lies immediately behind the projecting extremity of the latter.

Amputation of the phalanges of the toes. — A small and very narrow-bladed scalpel should be procured for these operations, which may be executed precisely in the same manner as the corresponding amputations on the hand. (See page 66, fig. 14.) The phalanges may be removed by a single palmar flap, or by double flaps.

The toes may also be removed at their metatarsal joints by the same shaped incisions, and in the same manner, as was recommended for the corresponding articulations of the hand (page 67). In amputating the great toe at its metatarsal joint, the operator should observe the prominence of the head of its metatarsal bone, and in the incision of the soft parts should provide accordingly for its sufficient covering.

Amputation of the toes en masse at their metatarsal joints. — The operator facing the sole of the foot, and being armed with a strong narrow knife, five inches in length in the blade, should grasp the extremities of all the toes with his left hand, his thumb being against their plantar surface; having extended the toes, he should make a curved incision from left to right, with its convexity directed forwards, across the sole of the foot, commencing on the right foot over the metatarsal joint of the little toe, and extending to the corresponding joint of the great toe on the opposite side of the foot. This cut should reach as far as the angles between the toes, and should fall on the transverse marks in the skin which separate the toes from the sole of the foot. The position of the left hand should now be changed, and the extremities of the toes be grasped, and strongly flexed; the thumb of the operator being now on their dorsal surface. Another curved incision should be made on the dorsum of the foot, joining the extremities of the first, and falling across the forks of all the toes (fig. 22a). The flap thus traced out may be reflected for a short distance, until the metatarsal articulations are exposed; these

being opened, and the capsular ligaments completely divided, the blade of the knife should be passed behind the heads of all the phalanges, and by a slight sawing movement should be made to cut its way close along the plantar aspect of their shafts, until it appears in the sole at the extremity of the first incision.

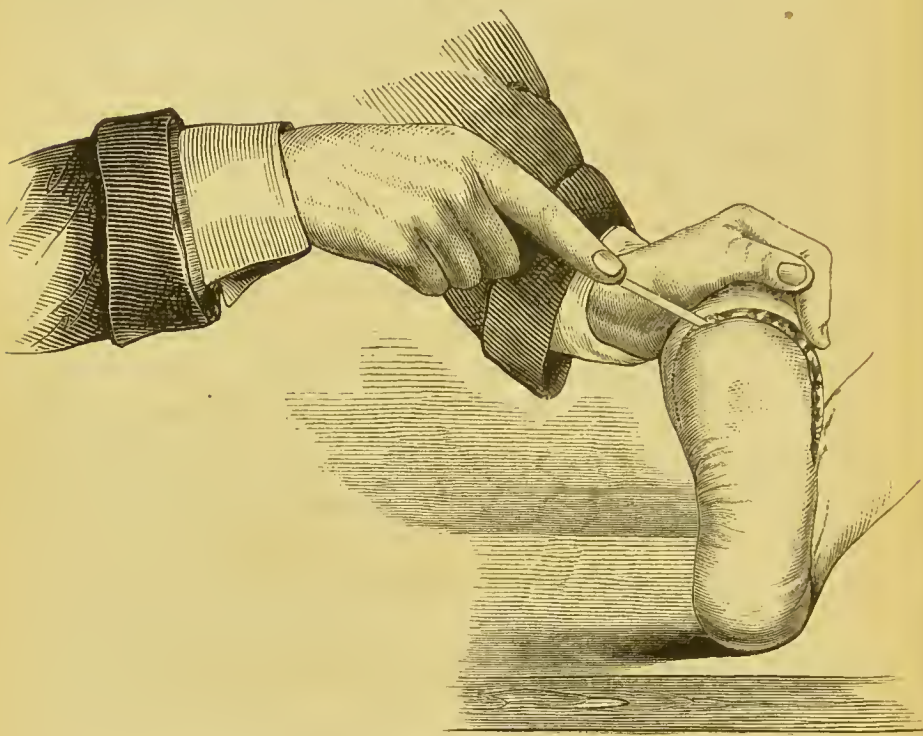
*Lisfranc's amputation.**—This consists in the removal of part of the foot, at the articulation between the tarsus and metatarsus. The operator should glance at the line of articulations he is about to open (fig. 22); he will perceive that with the exception of that belonging to the second metatarsal bone, they are arranged in a pretty regular curve across the dorsum of the foot; while the proximal end of the bone in question dips down towards the tarsus, and is wedged in between the first and third cuneiform bones: again, this and the first metatarsal bone are connected by strong plantar ligaments to the internal cuneiform bone; and lastly, the tendon of the peroneus longus is attached to the base of the metatarsal bone of the great toe; these connections, which must all be divided in this operation, form the principal difficulty in its execution.

The operator, having the same knife that was used in the last operation, should stand facing the right foot, the sole of which he should grasp in the palm of his left hand, the extremities of his thumb and forefinger being placed just behind the tarsal ends of the metatarsal bones of the little and great toes respectively. The former of these being prominent, its situation may be easily ascertained on the outer side of the foot, while the latter is found about an inch in advance of the prominence of the scaphoid on the inner side. These two points, marked by the finger and thumb, should be connected across the dorsum of the foot,

* Often called Hey's operation.

half an inch in advance of the articulations about to be opened, by a slightly curved incision, having its convexity turned towards the toes (fig. 22, page 91). The extremities of this first cut must now be joined by an incision running along the sides of the metatarsal bones of the great and little toes, and crossing the sole in a curved manner, just at the ball of the toes, as represented in the ad-

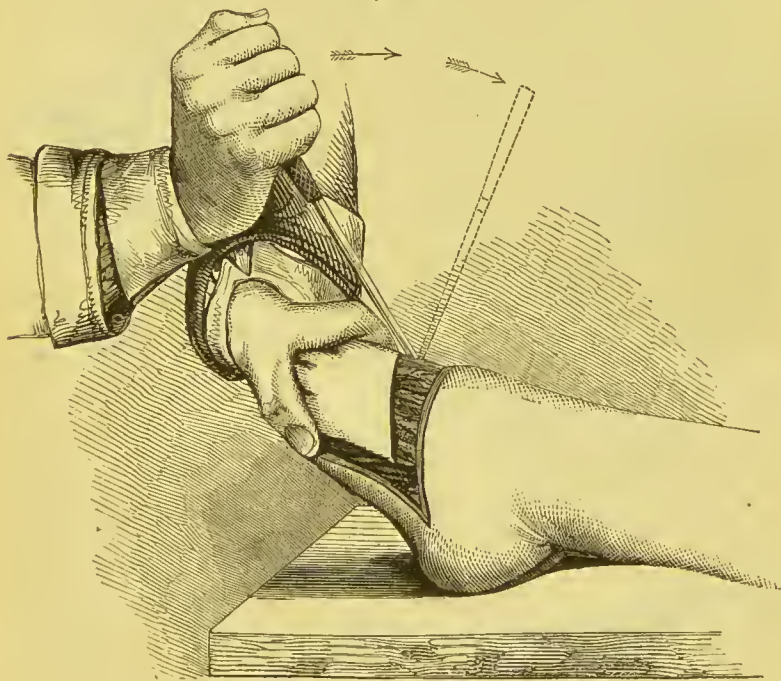
Fig. 23.



joining woodcut (fig. 23). This flap, traced on the sole, should be longer on its inner than on its outer side, and it should be cut deeply, down to the bones. The foot being now firmly grasped in the left hand, and the dorsal ligaments put on the stretch, they may be divided over the line of the tarso-metatarsal articulations, and the latter be opened. The knife should now be inserted between the shafts of the

first and second metatarsal bones, its point being directed towards the tubercle of the os calcis, and its edge looking upwards; it should be grasped in the fist, and should be made to move in a direction which we trust may be expressed by the accompanying woodcut (fig. 24); at the same time the left hand of the operator should bear downwards upon the end of the foot. The object of this pro-

Fig. 24.

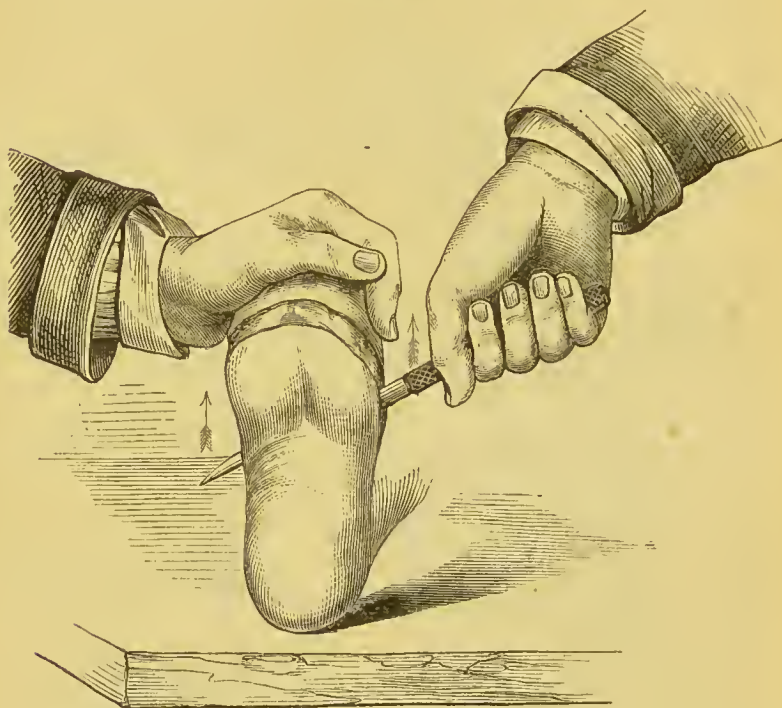


ceeding is to divide the ligaments at the base of the second metatarsal bone, and set its articular extremity free; the division of these ligaments is easily ascertained by the resistance to the left hand suddenly ceasing, and by the wide separation of the tarsus from the metatarsus. All the ligamentous connections of the bones being divided, the blade of the knife should be passed behind them into the sole, and being carried with a sawing movement close along the

under surface of the metatarsus (fig. 25), be made to cut its way out into the sole, at the extremity of the flap that has been previously traced.

Chopart's operation is the partial amputation of the foot at the articulation between the calcis and astragalus on the one side, and the cuboid and scaphoid bones on the other

Fig. 25.



(fig. 22); the principal covering for the stump being taken from the sole. We shall describe the operation as it is performed on the right foot.

The operator, grasping the sole of the foot in the palm of his left hand, should feel for the prominence of the scaphoid bone on the inner side, and having placed the end of his forefinger upon this, should next ascertain the position of the

peroneal tubercle* on the outer side, and marking its exact situation with the thumb of the same hand, let him make a curved incision across the front of the tarsus from a point an inch in front of the peroneal tubercle to the prominence of the scaphoid; and connect the extremities of this incision by tracing out a flap from the sole in the manner represented in fig. 23; this flap being curved at its extremity, and reaching just short of the balls of the toes, should, as in the preceding operation, be longer on its inner side than on its outer side. The dorsal ligaments of the tarsus being put on the stretch by bearing with the left hand upon the toes, and using the heel as a fulcrum, they should first be divided over the calcaneo-cuboid articulation, which is found half an inch in front of the peroneal tubercle, and subsequently over the articulation between the astragalus and scaphoid; these two joints being opened, the ligamentous connections of the bones should be entirely divided, and the blade of the knife passed to the under surface of the bones, and made, with a slight sawing movement, to cut its way out at the extremity of the plantar flap, in the manner exhibited in fig. 25.

Syme's amputation (fig. 22) consists in the removal of the foot at the ankle-joint, and the cutting off the malleoli, retaining the integuments of the heel as a covering for the bones; the chief difficulty experienced in this operation is the separation of the os calcis from its posterior and lateral connections, without injury to the integuments behind, or to the posterior tibial artery on the inner side: a knife not more than three or four inches long in the blade is required for this operation. The foot being drawn over the edge of the table, the operator should stand in front of it; he should make an incision from the tip of one

* It is found about an inch below and in advance of the outer malleolus.

malleolus to the other, straight across the under surface of the heel, and down to the os calcis in its whole extent; the ankle-joint should now be opened by a cut, connecting the extremities of the first incision, and running from malleolus to malleolus, across the front of the articulation. The foot being firmly extended, the joint should be fully opened, by dividing the lateral ligaments, and the os calcis be separated from its posterior and lateral connections by dissecting from above, down its posterior surface, the point of the knife being used, and this being kept close against the bone. Having freed the calcis from the tendo achillis and the parts about the inner ankle, the remaining integument of the heel is easy of separation, and may be disposed of with less caution. The projecting extremities of the malleoli being removed with the cutting forceps, the operation will be complete. In this proceeding, the arteries cut are the anterior and posterior tibial; their divided ends should be recognised, the former being looked for in front of the ankle-joint, the latter at the inner side of the plantar flap.

Roux's amputation of the foot is effected at the ankle-joint, the integuments on the inner and under side of the heel being saved as a covering for the stump. The operator, standing at the side of the foot, commences an incision at the apex of the outer malleolus, and carries it half across the front of the ankle-joint, from whence it should run inwards in an oblique direction over the astralago-scaploid articulation, then pass in a curved manner downwards and backwards to the mesial line of the sole of the foot, and running along the under surface of the heel, must ascend the posterior aspect of that part, and terminate at the outer malleolus, where it commenced. The ankle-joint should be opened on its upper and outer aspect, the calcis dissected from its connections (fig. 26), the malleoli

removed, and the operation will be complete. The shape of the flap may perhaps be gathered from the appearance presented by a foot upon which the operation has been performed. This is shown in fig. 27.

Pirogoff's operation is a modification of Mr. Syme's

Fig. 26.

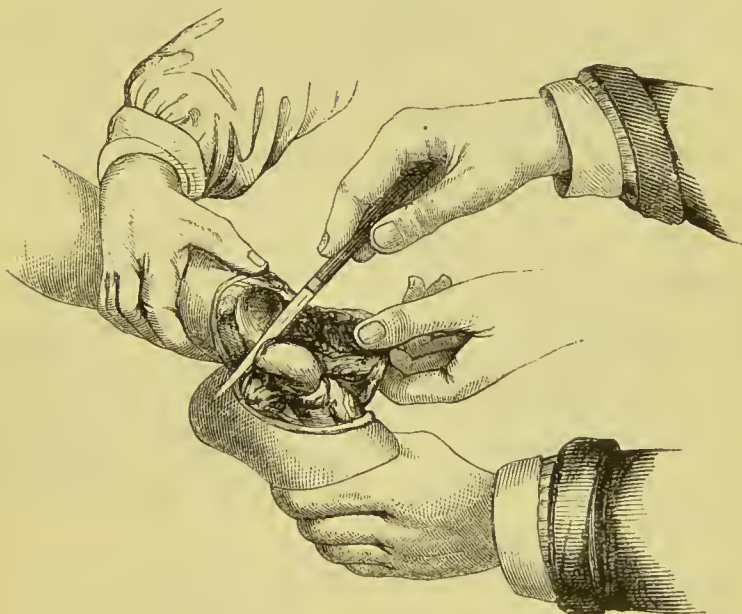


Fig. 27.



method. It differs from it, in that instead of completely removing the os calcis, in this operation the posterior part of that bone is sawn through obliquely and left in the heel, and the latter is retained as the covering for the ends of the

bones of the leg; it is more easily performed than Mr. Syme's operation, avoiding as it does the dissection of the soft parts from the posterior surface of the os calcis.

The operator turning the foot upwards, makes an incision down to the bone straight across the sole from the apex of one malleolus to the apex of that of the opposite side. Extending the foot, he now joins the extremities of this incision by another stretching across the front of the ankle-joint. Having opened the articulation, with the point of the knife he divides the lateral attachments of the astragalus until it so far comes out of the ankle-joint as to allow the os calcis to come into view behind it; with the foot in the same position, the saw should be placed behind the astragalus, and the os calcis divided vertically* downwards. The remaining connections of this bone being separated with the knife, and the ends of the tibia and fibula removed, the operation is complete. When the lower flap is brought up, the os calcis will be found to be cut obliquely, so as to come into more accurate apposition with the bones of the leg by its sawn surface.

An improved method of performing Pirogoff's amputation by Dr. Eben. Watson.—This operation is performed in the following manner. The operator stands on the right hand side of the limb, and, turning up the sole by flexing the foot, he makes an incision down to the bone from the tip of one malleolus to the other, across the under surface of the heel; into this wound the saw is introduced, and the posterior part of the os calcis sawn off behind the astragalus, the section being carried in a direction upwards and inclining backwards. The heel is now retracted by an assistant, the knife applied between the sawn surfaces of bone, and made to cut its way upwards for a short distance

* In this position of the foot the section should be vertical.

behind the ankle-joint (fig. 28). The operator now joins the extremities of his first incision by cutting straight from malleolus to malleolus across the front of the ankle, and

Fig. 28.

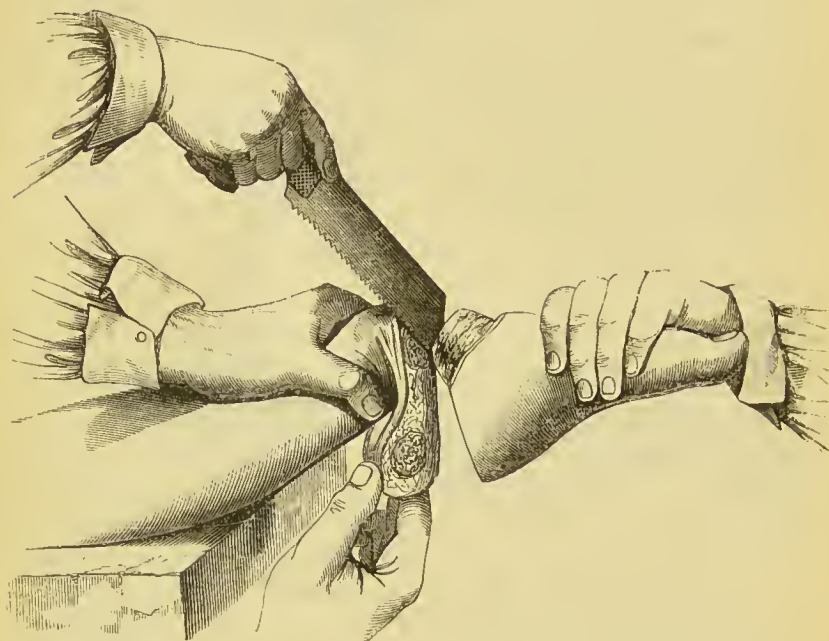


dividing all the tendons and soft parts down to the tibia ; these being retracted, and the bones of the leg cleared at their lowest part, their articular surfaces, with the malleoli, should be sawn off. This section should only include a thin shell of bone, and should be carried nearly at right angles to the long axis of the bones, though with a slight inclination *upwards** (fig. 29).

* In this particular we have ventured to differ from Dr. Watson's recommendations, as given in the "Lancet," June 11, 1859. He there recommends that the bones of the leg be sawn "from before backwards and downwards."

The foregoing operation is more easy of execution than the ordinary method of performing Pirogoff's amputation; and, among other advantages which it possesses, we may allude to the exact adaptation of the parts to each other

Fig. 29.



when brought together after the operation, and to the greater ease with which it is performed on the living body when the foot is too mutilated to allow of its being firmly grasped.

Amputations of the leg.—The leg may be removed by the (1) circular; (2) the double-flap operation; (3) by a combination of the two preceding; (4) by Mr. Teale's method. Before commencing any of these operations, it may be well to observe the conformation of the leg in respect to the position of its bones and the relation that these bear to one another. The great preponderance of soft parts on the

posterior aspect of the limb cannot fail to attract attention ; and the relative position of its bones being examined, they will be found not to lie in the same horizontal plane, but rather the one somewhat posterior to the other, the fibula being hindermost. The remembrance of these points will, in the performance of the flap operation, facilitate the formation of flaps bearing a proportionate size to each other*, and will render impossible either the thrusting of the knife between the bones, or the empalement of the more distal bone with its point,—accidents which occasionally occur even on the living body.

(1.) *The circular method.*—This may be performed at any part of the leg, but it is usually preferred in amputations high up the limb, in which the patient eventually supports the weight of the body on the bended knee, and not on the extremity of the stump ; indeed the covering and protection afforded to the ends of the bones by this operation are scarcely sufficient to support the weight of the body.

The operator should stand outside the limb, which must be pulled over the end of the table and supported ; while the assistant retracts the soft parts just above the part to be amputated. He should now sweep the knife around the limb so as to divide the integument in its entire circumference ; this being retracted by the assistant and dissected back for three or four inches, must be turned over on itself like the cuff of a coat. The muscles should be divided in a circular manner as high up as possible, an interosseous knife passed around and between the bones in front and behind, and the saw applied so that in dividing the bones, the section of the fibula be completed, though not commenced before that of the tibia. The anterior and

* *Vide* Mr. Skey's remarks on the subject, "Operative Surgery," page 397, 2nd edition.

posterior tibial and the peroneal arteries will have been divided; and if the amputation has been performed in the upper third of the leg, some little difficulty may be experienced in recognising the end of the anterior tibial, which, at the point where the bones are sawn through in this operation, is involved in the fibres of the interosseous membrane.

(2.) *Double-flap amputation of the leg.*—Though used in operations on any part of the limb, it is generally preferred in those performed in the lower two-thirds. As the anterior flap in this part of the body is formed by cutting, and not by transfixion, it is convenient to stand on the right-hand side of the limb, while the latter must be supported as in the preceding operation. The operator should place the thumb and fore-finger of his left hand on the posterior margins of the tibia and fibia respectively, and from one to the other should make a semilunar incision, with its convexity towards the foot, thus tracing a flap on the anterior and outer aspect of the limb about four inches long, and being at its base, half the circumference of the leg in width. This incision may be made to extend pretty deeply, so as to include as much as possible of the subjacent muscles; the whole being reflected to the full extent, the soft parts at the back of the limb may be transfixed, the point of the knife entering at the termination and coming out at the commencement of the first incision, thus passing behind both bones. This proceeding may be facilitated by adopting the plan recommended in amputation of the forearm, and represented in fig. 18. A posterior flap of the same shape, though somewhat longer than the anterior, being cut, the interosseous knife should be passed around and between the bones at the angle of junction of the flaps, the saw applied as in the preceding method, and the operation will be complete. If this amputation be practised in the middle third of the leg, the anterior tibial

artery will be found in front of the interosseous membrane; the posterior tibial a short distance behind that structure; and the peroneal under the sawn edge of the fibula.

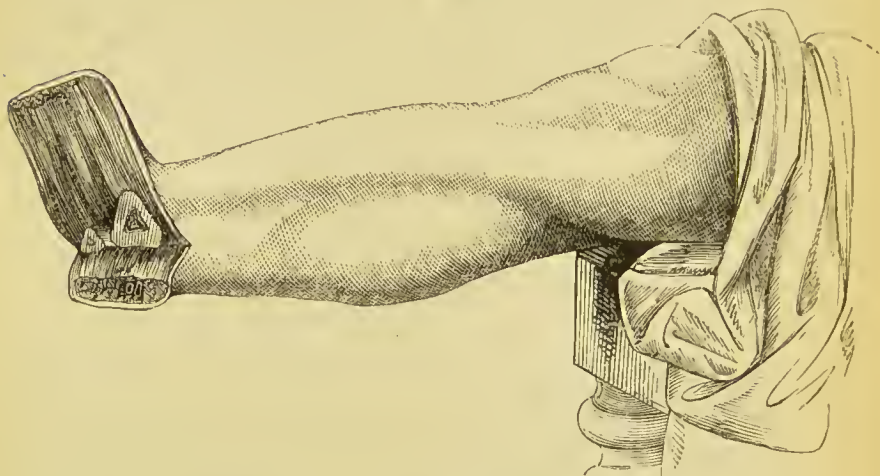
(3.) *Amputation by integumental flaps and circular division of the muscles.*—This method may be made use of with great advantage in any part of the leg. The operator stands on the right-hand side of the limb, and, marking the posterior borders of the tibia and fibula with the forefinger and thumb of the left hand, he traces and subsequently reflects a semilunar flap formed of integuments, extending across the anterior and outer aspect of the limb from the posterior margin of one bone to that of the other, and reaching downwards for about four inches. Next he forms and reflects a posterior flap by connecting the extremities of his first incision. At the base of these flaps, the posterior of which should be the longer, the muscles are to be divided in a circular manner, and, being retracted as far as possible, the interosseous knife may be applied, and the bones sawn in such a way that the section of the fibula is completed before that of the tibia. It is the practice with some surgeons, before bringing the parts together, to saw off the projecting spine of the tibia in an oblique direction from above downwards.

(4.) *Amputation by rectangular flaps.*—Mr. Teale recommends this operation in either the middle or upper thirds of the leg; and in all cases he advises that the flaps be carefully measured and traced upon the limb before its performance.* The operator, standing on the right-hand side of the leg, should trace out with his knife the lateral boundaries of the anterior flap. This should be quadrangular, the width of half the circumference of the limb, and the same length; its lateral incisions should run along the posterior margins of the tibia and fibula respectively, and

* For the general rules for performing this operation, see page 62.

should divide the integuments alone. These incisions being connected at their lower extremities by a transverse cut dividing everything down to the interosseous membrane, the long flap should be dissected upwards, with all the struc-

Fig. 30.



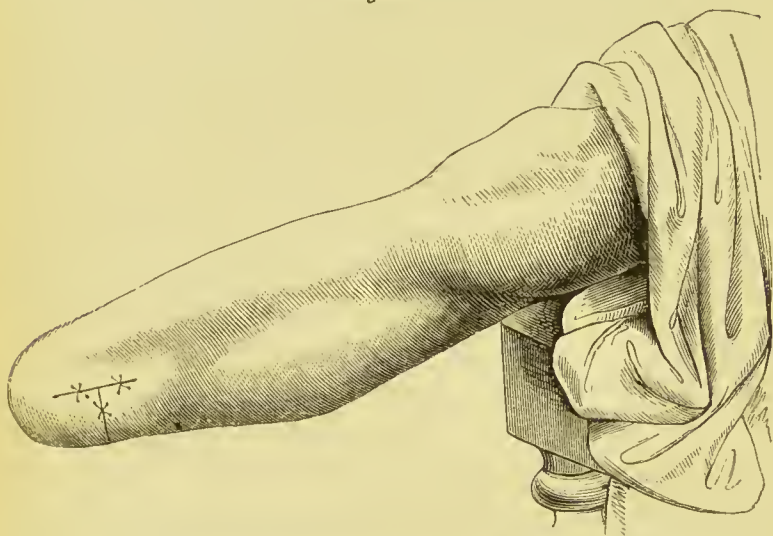
Appearance of the wound after Mr. Teale's operation.

tures in front of the bones and interosseous ligament. The posterior flap, one-fourth the length of the anterior, should be made by a direct cut through everything down to the bones, and separated as high as the point where it is intended that the bones should be sawn. To aid our description, we refer to fig. 30, copied from Mr. Teale's book. The wound is brought together as in all cases where this method has been employed; namely, the upper flap is doubled on itself, and thus folded over the ends of the bones, its extremity being fixed by suture to the extremity of the short flap, and its reflected portion connected to its unreflected portion in a similar manner (fig. 31).

Amputation of the leg at the knee-joint.—This is an operation by a single flap, which is cut from either the anterior or posterior aspect of the limb.

(1.) *Anterior flap operation.*—The leg being drawn over the edge of the table, the operator should stand on the right-hand side of the limb, and trace out on the front of the leg a flap with a rounded extremity six or seven inches long, and extending laterally from one hamstring to the opposite; this incision should begin at the posterior part of one condyle of the femur, and terminate at the corresponding spot on the other side of the limb. An incision

Fig. 31.



Manner of bringing the wound together after Mr. Teale's operation.

should now be made through the integuments alone straight across the back of the knee-joint, connecting the extremities of the first; the operator having reflected the anterior flap so as to expose fully the front of the knee-joint, must open the articulation on its anterior aspect while the limb is flexed, and dividing the ligaments, should cut straight through the joint, bringing the knife out at the posterior incision. The popliteal artery will be found at the back of the femur between the condyles, and nearer to that bone than its companion-vein, from which it can only be distin-

guished by its position. The patella may be left, or it and the articular surface of the femur may be removed, at the discretion of the operator.

(2.) *The operation by a posterior flap.*—This is effected by making slightly-curved incisions across the front of the joint from condyle to condyle, and reaching below the patella. Having raised the integuments over the joint, it should be opened in front and its ligaments divided. The knife should now be passed through the articulation behind the head of the tibia, and a posterior flap be cut from the calf six or seven inches long, and as broad as possible at its extremity, as it has to adapt itself to the condyles of the femur; this will complete the operation. Of the two methods, the former is by far the best.

Amputation of the thigh is performed in any part of its length: and the methods most in use are (1.) the circular; (2.) the flap; (3.) circular of the muscles and flap of the integuments; (4.) Mr. Teale's method.

(1.) The circular operation may be performed in any part of the thigh, and as its execution is the same in all its details, whether it be effected in the lower or upper third, we shall describe the operation once for all. The operator standing on the outside of the limb, his assistant being on the same side and somewhat behind him, the limb should be drawn over the edge of the table, and supported in a horizontal position: let the assistant retract the integuments above the part selected for amputation, and this he may best do by encircling the limb with both hands. The heel of the knife being laid on the side of the limb nearest to the operator, the integuments should be divided with one circular sweep of the knife if possible*, so as to free them from their connection with the muscles and deep fascia.

* The manner of effecting this is described in detail at page 78.

While the assistant still forcibly retracts, let the operator pass the knife again and again around the limb, each time dividing fresh bridges of connective tissue between the integuments and the muscles, until sufficient integument has been obtained for covering the stump. The assistant should now take a fresh grasp of the limb, and keeping the integuments well out of the way of the knife, the operator must divide all the remaining tissues down to the bone in the same manner that the skin was divided; if the soft parts be still firmly retracted, the stump will now assume a somewhat conical shape, owing to the more superficial muscles retracting to a greater extent than those more closely connected with the bone; these should be again divided, by passing the knife around the femur about an inch from the extremity of this muscular cone, and the saw applied as high up as possible. In using the saw, the operator should grasp the bone just below the point of section, with his left hand, that he may thus the more effectually steady it. If this operation has been performed in the lower third of the thigh, the large vessels will be found near to the bone on its inner side.

(2.) *Amputation of the thigh by double flaps.*---In this operation the flaps are formed, the one from the anterior and outer aspect of the limb, the other from its posterior and inner side. The operator should stand on the outer side of the limb, the assistant occupying the same position as in the preceding operation; the soft parts in front and to the outer side of the bone being grasped and raised by the left hand, a sharp-pointed amputating knife should be introduced on the outer side of the limb, rather nearer its posterior than its anterior aspect, and being pushed onwards over the front of the bone, should emerge at a corresponding point on the opposite side; the parts held in the left hand may now be suffered to drop a little, while

an anterior flap is cut about five or six inches in length, decreasing in thickness towards its extremity, which must be curved, and not left too thin at the edge. The assistant should gently raise this flap, while the operator passes the knife behind the bone, between it and the remaining undivided parts, and cuts a posterior flap the same shape as the anterior, but an inch or two longer: by drawing the soft parts downwards away from the bone, the transfixion of the limb on its posterior aspect will be much facilitated, both flaps being now retracted, the heel of the knife may be passed around the bone at their point of divergence and the saw applied. In transfixing the thigh in its lower half, the knife, if possible, should pass in front of the femoral vessels; while in the upper half of the thigh the main artery will necessarily be situated in the anterior flap: the operator, in amputating above the middle of the thigh, should guard against transfixing these important structures.

(3.) *Amputation by double flaps of the integument and circular division of the muscles.*—The operator, standing on the right hand side of the limb, *i. e.* on the outside of the right thigh and on the inside the left, must trace on its anterior surface a semilunar flap, the width of half the diameter of the limb at its base and about five inches long; this being formed of integuments alone, should be reflected and a posterior flap of the same shape and dimensions should be made, by connecting the extremities of the first incision; both being retracted, the muscles may be divided, and the operation completed as in the circular method of amputation.

(4.) *Amputation by a long and a short rectangular flap.*—For the general directions for performing this operation we refer the operator to page 62; in performing it on the lower two-thirds of the thigh, the operator should stand on the outside of the limb, and should trace one of the lateral

incisions of the long flap, just anterior to the line of the femoral vessels, while the other should be on the outer aspect of the part, half the circumference of the limb distant; these incisions should include the integuments alone, the transverse cut connecting their extremities may be made by a single sweep of the knife, dividing all the soft parts down to the femur; the flap is completed by reflecting the fleshy structures from below upwards, close to the bone. The posterior short flap, containing the large vessels and nerves, should be made by dividing all the soft parts on the posterior aspect of the limb, and separating them from the bone as far upwards as the point where this is to be sawn. The flaps are brought together in the manner shown in fig. 31, and described at page 106.

Amputation of the thigh at the hip-joint.—The lower limb may be removed at its pelvic articulation in several ways; the chief difference in these methods, consists however, in the formation of a covering for the wound, from one or the other aspect of the limb. We venture to think that the operation by an anterior flap, where practicable, is the most suitable operation, and to this we shall more particularly allude.

The subject being drawn to the end of the table, so that the tuberosity of the ischium may rest on its edge, the operator should take his place on the outer side of the limb to be removed; the assistant standing behind him, and, if necessary, holding the scrotum aside. A sharp-pointed knife of sufficient length being provided, its point should be inserted midway between the anterior superior spine of the ilium and the top of the great trochanter; from here it must be thrust downwards and inwards parallel with the fold of the groin, and passing close in front of the head of the thigh-bone, should emerge at the inner side of the limb

two inches or so below the descending ramus of the pubes. In effecting this it is advisable for the operator to lay his left hand over the front of the joint, to ascertain when the point of the knife has reached the capsule of the hip-joint, which, if possible, should be opened on its anterior aspect, by this incision. Having arrived at the head of the bone, the point of the knife may be considerably depressed, so that fully half the soft parts of the limb may be included in the anterior flap, which should be cut about eight or ten inches in length, and rounded at its extremity. The assistant should retract this flap with some force, while the operator grasps the limb just above the knee, and depressing the thigh, puts on the stretch the capsular ligament, which, with the ligamentum teres, must be divided, and the bone dislocated upwards. The external rotator muscles being separated from the bone, and its head being quite free from all attachments, the operator may at once pass the knife behind it, and cutting vertically downwards through the remaining soft parts, may remove the limb. It is the practice of some surgeons, after having completely freed the head of the bone, to pass the knife behind the limb, and cut straight across its posterior aspect from the inner to the outer angle of the wound, and from its cutaneous to its deeper surface.

In the foregoing operation there is no posterior flap; the wound will therefore be on the most dependent aspect of the limb, tending much to its cleanliness, and in the living body to the comfort of the patient. This operation may be modified by making an anterior and posterior flap of equal dimensions, or by forming a short anterior with a long posterior flap.

The vessels divided in this proceeding are both numerous and large; those that demand the greatest attention are the superficial and deep femoral, the obturator, and sciatic. In

the living body the arrest of hemorrhage from the femoral trunk is the duty of an assistant, who should compress it at the pelvic brim during the formation of the anterior flap; and so soon as this is turned back, should seize its open end between his forefinger and thumb, and hold it until the remaining vessels are tied.

Amputation of the penis.—This operation differs from all other amputations, in that while in those it is essential to provide a tegumentary covering for the stump, it is the design of this to leave the corpus spongiosum prominent for the necessities of urination. In performing the operation it is well to bear in mind the retractile nature of the corpora cavernosa, for these, after division, tend to draw with them the corpus spongiosum downwards towards the scrotum, and to embed the orifice of the urethra in the loose integument of that part.

The operator, standing on the left-hand side of the body, and grasping the extremity of the penis in his left hand, should draw the integument towards the glans; he may now with one vertical sweep of a long knife remove the organ, or he may carry the section obliquely through the parts from behind forwards and above downwards, so as to leave the corpus spongiosum the most prominent of the three bodies on the surface of the stump. Again, he may divide the skin in a circular manner, and allowing it to retract, may cut the deeper structures on a level with the lower margin of the wound in the integument. There are generally four arteries which require ligature in this operation: the two dorsal vessels, which are found beneath the skin of the penis on its upper surface, and the two arteries of the corpora cavernosa, which lie deeper, in those bodies from which they derive their name. It is recommended by some surgeons to complete the operation by attaching the margins of the mucous membrane of the urethra to the

cut edge of the common integuments of the part. The urethra before being sewn to the external skin should be split into three divisions, to allow of its orifice being spread out.

Castration.—To remove the testicle, the body should be drawn to the edge of the table and the thighs separated, while the operator, standing between them and facing the abdomen, should grasp the hinder part of the scrotum with his left hand, pinching it up, and thus throwing forward the testicle and tightening the integuments over it and the spermatic cord. Let him now make a nearly vertical incision, commencing at the external abdominal ring, extending downwards to the lower part of the testicle, and laying bare the gland; forcing the latter forward by tightening the grasp of his left hand, with the point of the scalpel the operator should dissect off the coverings of the cord at that point where it leaves the testicle. When completely isolated, this part may be included in a strong ligature, or held by an instrument for the purpose, to prevent the retraction of its upper end. It should now be divided just above the epididymis, its lower end grasped by the operator, and the testicle dissected out from above downwards, while the scrotum is held aside by an assistant. The superficial pudic artery is divided in this operation in making the first incision, and in the living body generally requires ligature; in the section of the cord the spermatic, deferential, and cremasteric vessels are divided.

CHAP. VIII.

RESECTION OF ENTIRE BONES AND JOINTS.

Resection of joints and entire bones.—Instruments.—Phalanges of the fingers —Phalangeal joints : (1) by lateral incisions, (2) by a dorsal flap.—Metacarpal bone of the thumb.—Metacarpal bone of little finger.—Wrist-joint : (1) by lateral incisions, (2) a semilunar flap, (3) Mr. Butcher's method.—Carpal end of the ulna.—Elbow-joint : (1) Liston's method, (2) H-shaped incision, (3) Langenbeck's operation.—Shoulder-joint : (1) by a semilunar flap, (2) by a longitudinal incision, (3) Stromeyer's method.—Excision of the lower jaw.—Excision of the upper jaw.—Resections of the lower extremity.—Phalanges and phalangeal joints of the toes.—Metatarsal bone of great toe.—Ankle-joint.—Knee-joint.—Hip-joint.

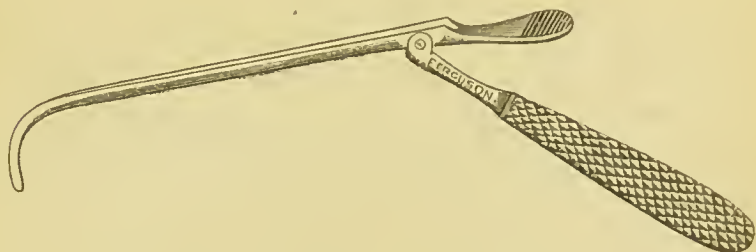
It is usual to practise the resection of entire bones upon the dead body, though the performance of these operations in many cases gives but a faint idea of their execution on the living. It is not so with resections of joints; for in the case of these, considerable facility of execution may be acquired by practice on the dead body, a facility which it is important to possess for their successful performance on the living.

Resection in most cases aims at the complete destruction of an articular cavity, and the bringing together of two fresh cut surfaces of bone. This can be accomplished in the majority of the articulations of the body, though there are some where the anatomical disposition of the parts does not admit of the complete removal of the whole articular surface.

For resections generally, two or three scalpels of different sizes should be procured, a small strong saw,—a large

metacarpal saw will answer all purposes; a director, such as represented in fig. 32*; a pair of cutting bone forceps, and the lion forceps, as they are called, for grasping bones.

Fig. 32.



Armed with these, and having secured the services of an assistant, we may proceed to the performance of any of the operations described within this chapter.

Resection of the phalangeal bones of the fingers. — These bones may be removed in their entire length, by making two lateral incisions, rather nearer the dorsal than the palmar aspect of the finger, one on either side the bone to be removed. These cuts should extend at either end just beyond the phalanx. The flexor and extensor tendon being dissected from their sheaths, the lateral ligaments at one articular end of the bone should be divided, while they are put on the stretch by bending the finger laterally: this extremity of the bone being cleared from its connections, it should be grasped, and the remaining attachments divided.

Resection of the phalangeal joints of the fingers. — This may be effected in two ways: 1st, by making two lateral incisions, one on either side of the articulation; 2nd, by a semilunar flap, made over the dorsal aspect of the joint.

* This director is used for passing under bones that are to be sawn; it is passed around the bone, and the handle is then used to turn it with its groove upwards: it is especially useful in the neighbourhood of tendons.

The former method leaves both the extensor and flexor tendon uninjured, the latter divides the extensor.

(1.) Make an incision parallel with the long axis of the finger on either side of the joint, and dissect the tendons and soft parts from the articular extremities of the bones, keeping the point of the knife close to the bones to ensure the safety of the tendons; put the lateral ligaments on the stretch, and divide them while the joint is flexed laterally—the ends of the phalanges can now be extruded from the wound, and they may be removed with the bone forceps or a saw.

(2.) A semilunar flap, with its convexity directed towards the ends of the fingers, should be cut over the back of the joint, and all the soft parts dissected off. Bend the joint as much as possible and open it on its posterior aspect, clearing the ends of the bones from their connections; remove their articular surfaces as in the preceding operation.

Resection of the metacarpal bone of the thumb.—Having procured a strong and narrow scalpel, make an incision on the dorsal aspect of the metacarpal bone of the thumb, commencing midway between the styloid process of the radius and the articulation of the thumb with the trapezium, and extending along the palmar border of the extensor primi internodii up to, or rather beyond, the base of the first phalanx. Carefully dissect away the soft parts from the shaft of the bone, until it is sufficiently isolated to be grasped with the finger and thumb of the left hand. Put the bone in a position of extreme flexion, and divide the extensor ossis metacarpi at its insertion into the base of the bone; disarticulate the latter from its connection with the trapezium, and grasping this end of the bone, pull it out of the joint and pass the knife behind it, separating the soft parts on its anterior or palmar aspect; and, finally,

divide its attachments to the first phalanx, twisting the bone hither and thither to facilitate this process.

The fifth metacarpal bone may be resected in a similar manner by an incision made along its ulnar border.

Resection of the wrist joint. — This operation, owing to the complexity of the articulation on which it is practised, is necessarily imperfect in its nature; that is, the opposed articular surfaces cannot be completely removed, and thus the most favourable conditions for resection cannot be fulfilled.

The principal methods of performing the operation are three: 1stly, by lateral longitudinal incisions running along the subcutaneous margins of the radius and ulna respectively, leaving all the tendons uninjured; 2ndly, by forming a semilunar flap on the back of the joint, dividing all the extensor tendons; and, 3rdly, Mr. Butcher's method, in which the extensor tendons of the thumb are left intact.

The first plan is certainly practicable on the dead body, but must be quite impossible in many cases on the living where the joint requires removal. It is effected by making two lateral incisions, one on either side the joint, along the subcutaneous borders of the radius and ulna respectively; commencing half an inch in advance of each styloid process, and extending up the forearm for three inches or more. The soft parts should first be carefully dissected from the ulna until the director can be passed around the bone and its groove turned upwards; this being effected the bone may be sawn upon the director about an inch above the wrist, the lower fragment grasped with the forceps and disarticulated with the point of the knife. The radius should now be freed from the tendons which surround it, by dissecting chiefly from its outer to its inner border; the director being passed around it to keep these aside, the bone may be sawn off and separated, as in the case of the ulna.

(2.) *A semilunar flap* is cut from the back of the wrist,

with its convexity towards the hand, and extending all across the joint; the soft parts down to the bones are reflected, the joint opened from behind, and the carpal extremities of the bones of the forearm removed, when cleared from their connections.

(3.) *Mr. Butcher's modification* consists in making a semilunar flap with its convexity towards the hand over the back of the joint: the incision should commence just to the ulnar side of the tendon of the extensor secundi internodii, and terminating on the subcutaneous border of the ulna, an inch higher up the forearm than the point where it commenced. All the extensor tendons of the fingers are divided and reflected, while those of the thumb are dissected from their grooves and drawn to the radial side; the joint is opened from behind, and the ends of the bones disarticulated and sawn off.

The carpal extremity of the ulna may be resected by a longitudinal incision made along its subcutaneous border, the bone being separated as in resection of the wrist-joint; in detaching its lower end the styloid process may be sawn off, and in this way the integrity of the wrist-joint will be preserved.

Resection of the elbow-joint. — The variety of incisions adopted for the resection of this joint is very great, though they all have for their object the adequate exposure of the joint, without undue division of the soft parts, or injury to the ulnar nerve. This nerve lies on the inner and posterior side of the articulation, deep between the inner condyle of the humerus and the olecranon process of the ulna.

The methods of resecting this joint most in use at the present day are: (1) Liston's method; (2) the H-shaped incision used by Mr. Syme; and (3) Langenbeck's single longitudinal incision. During the performance of these operations the limb should be held by an assistant in a slightly flexed position.

(1.) *Liston's method*, which we venture to think fulfils all requirements, consists in making a cut shaped ∇ , the long limb of which is commenced about two inches above the olecranon, and is continued downwards for three inches or more, along the ridge at the back of the ulna, or between this and the ulnar nerve. This cut should extend down to the bone in its whole length. The transverse incision is now made across the radio-humeral articulation and back of the elbow-joint, joining the first at its centre, and opening the elbow-joint. A blunt hook or the finger should be placed within the joint, and the soft parts with the ulnar nerve drawn over the inner condyle, while they are separated from the bones with a knife. The lateral ligaments being now divided, the joint should be strongly flexed by the assistant, and the ends of the bones turned out of the wound and completely freed from their connections. The articular surfaces of the bones should be separately sawn off, commencing with the ulna. If possible the coronoid process of this bone and the tubercle of the radius should be preserved, thereby securing the integrity of the biceps and brachialis anticus muscles.

(2.) *The H-shaped division* of the soft parts is made at the back of the joint, the transverse part of the incision crossing the joint just above the olecranon, and the longitudinal cuts falling over the radius and ulna respectively. This is the easiest method of performing the operation, though perhaps the extent of the wound is greater than need be.

(3.) *Langenbeck's operation* is effected by a single longitudinal cut, at the back of the joint running down the ridge on the ulna, and extending upwards for three or four inches. This is practicable on the dead body; but on the living the incision is generally insufficient to bring the bones fairly into view, unless it be prolonged to an unde-

sirable extent. It is seldom that any blood vessels of considerable size are divided in this operation.

Resection of the shoulder joint.—The head of the humerus, in addition to its ligamentous connections, has in front of it, lying in a groove, the long tendon of the biceps, and is attached on its upper and outer aspect to the supra spinatus, infra spinatus, and teres minor muscles; while on its inner and under side is inserted the subscapularis muscle.

Closely encircling the neck of the bone in front, is the anterior circumflex artery, and behind it is the posterior circumflex artery with the corresponding nerve. The upper and outer aspect of the joint is completely enveloped by the fleshy fibres of the deltoid. There are three principal methods of exposing the cavity of the shoulder joint for resection.

(1.) The old plan of forming a semilunar flap from the deltoid muscle.

(2.) By a single longitudinal incision.

(3.) By Stromeyer's operation.

The shoulder of the subject should be raised on a block, and the operator should stand facing the joint; the assistant may be placed at the head of the subject, facing the operator.

In the *first method* a short semilunar flap, including all the subjacent soft parts, is either cut, or transfixed by grasping the deltoid and raising it. The base of this flap should correspond with the acromion, its convex border be directed towards the elbow, and it should be situated on the upper and outer side of the joint. The assistant should raise this flap to the full extent, while the operator, having divided the long tendon of the biceps, grasps the arm near the elbow with his left hand, and rotates the head of the bone forcibly inwards; this will expose the three tendons inserted into the greater tuberosity, which are best divided by laying the heel of the knife on the head of the bone, and cutting

from within outwards, over the upper side of the joint: now rotate the bone in the opposite direction, and divide the tendon of the subscapularis, at the same time completing the division of the capsule of the joint. Pass the director round the neck of the bone to protect the soft parts, and saw off the head.

(2.) The plan which generally goes by the name of Langenbeck's operation, is that which he made use of during the Schleswig Holstein war. Its object is to save the long tendon of the biceps, and to avoid the transverse division of the fibres of the deltoid.

A longitudinal incision is made, commencing at the most prominent point of the acromion, and extending downwards for four or five inches. This should fall just over the bicipital groove, and should divide all the structures down to the bone; the tendon of the biceps being disengaged from its groove, and, together with the edges of the wound, being held aside by the assistant, the operation may be completed as in the last discussed method, though it will be found that its execution is more difficult.

(3.) Stromeyer makes use of a semicircular incision, commencing at the posterior edge of the acromion, and extending downwards and outwards for three inches or more, having its concavity directed forwards. The joint is thus freely opened on its upper and posterior aspect, the tendon of the biceps can be preserved, as in the preceding operation, and a dependent aperture is left for the secretions of the wound.

Removal of the lower jaw. — We proceed to describe this operation before treating of excision of the superior maxillary bone, as its performance does not prevent the subsequent execution of that operation. With care, on the same face both sides of the inferior maxilla may be removed as well as both superior maxillary bones.

It is only necessary to describe the method of removing half this bone : should the whole need removal, it is best accomplished by cutting the bone in two, and removing each half separately.

In addition to the ordinary instruments required for resection, a small shallow-backed saw should be procured, and forceps for the incisor teeth. The head should be slightly raised, and the operator should face the subject. Having extracted one of the central incisor teeth, an incision must be made along the lower border of the jaw, commencing at the symphysis and extending up the ramus nearly as far as the zygoma ; the facial artery should be recognised, as at this stage of the operation on the living body, it has to be tied. The masseter muscle with the soft parts must be reflected upwards from the bone, until the cavity of the mouth is reached ; the flap thus formed being held aside by an assistant, the saw is to be applied to the bone at that part where the tooth has been extracted, until a pretty deep groove has been cut ; to this apply the cutting bone forceps, and complete its division. The part to be removed should now be grasped at its extremity with the lion forceps and be drawn upwards, away from the deeper structures, while a narrow-bladed scalpel is inserted beneath the bone and drawn outwards and upwards along the under surface of the body and ramus, keeping close to the bone in its course. This will allow the jaw to be twisted upwards so as to expose the attachment of the pterygoid and temporal muscles ; having divided these and the inferior dental nerve, the ligamentous connections of the condyle may be severed, while the bone is twisted hither and thither to allow of the application of the scalpel. The operation is now complete.*

* After the performance of this operation, the application of the twisted suture may well be practised on the wound.

An important point to remember in the foregoing operation, is to be careful to keep the edge of the knife close against the under surface of the bone, while dividing the deeper parts; and the only difficulty in its performance, is the complete division of the insertion of the temporal muscle on the inner surface of the coronoid process, and that of the external pterygoid in front of the condyle of the jaw.

Removal of the upper jaw.—This operation, if there is a scarcity of bodies, may be performed on the same side of the face as that from which the lower jaw has just been removed, if not on the opposite side.

The principal attachments of this bone, which must be divided before it can be removed, are the articulations on its outer and upper angle with the malar bone, its articulation by the ascending or nasal process with the frontal bone, and its junction in the middle line of the hard palate with the bone of the opposite side. These points must be divided with the bone forceps; its remaining connections may be torn through. Besides the ordinary instruments, forceps for the upper incisor teeth are required for this operation, and large-cutting bone forceps.

The head of the subject being raised on a block, and the operator standing facing the body, on its right-hand side, one of the central incisor teeth should be drawn, and a curved incision be made with its convexity downwards, beginning at the angle of the mouth, and extending upwards and outwards to about the centre of the malar bone. Having recognised the position of the facial artery, this flap should be drawn upwards by an assistant, while it is dissected from its deep connections until the lower margin of the orbit is exposed: inwards it should be reflected so as to separate the lateral cartilage of the nose from the bone, and expose the cavity of the nostril and the nasal process of the upper jaw; and externally it must

be thrown back as far as the malar bone. The mucous membrane on the floor of the nostrils and roof of the mouth may now be divided longitudinally from behind forwards by an incision, falling just aside of the middle line, and ending at the alveolus occupied by the incisor tooth just extracted. The operator, taking in hand the cutting forceps, should place one blade in the nostril and the other in the mouth, and thus divide the hard palate; next, placing one blade in the nostrils against the nasal process of the bone, and the other in the inner angle of the orbit at its lowest part, he should cut the nasal process; lastly, he should separate the upper jaw from its connection with the malar bone,—and this may be effected at one stroke of the forceps, cutting from under the malar bone into the inner angle of the orbit; or better, by two separate divisions, first cutting upwards, and subsequently backwards into the inner angle of the orbit and speno-maxillary fissure. The lion forceps being now fixed firmly into the bone, it may be twisted from its remaining attachments, the knife being used to divide the superior maxillary nerve or any of the soft parts that may need its application.

There is another and perhaps a better plan of incising the skin of the face for this operation. It was first adopted, we believe, by Mr. Fergusson. It consists in cutting through the middle line of the upper lip to the margin of the nostril, and continuing the incision close around the alar cartilage, up the side of the nose to the inner angle of the eye, and if necessary, prolonging it outwards along the inferior margin of the orbit. This method has the advantage of leaving a more sightly cicatrix than the plan usually adopted.

It often happens on the living body, that circumstances admit of the orbital portion of this bone being left undisturbed; this may be done by sawing transversely across

the bone below the lower rim of the orbit, from the nostrils to the malar bone.

We would recommend the operator now to proceed with the resections of the lower extremity, commencing at the toes.

If it were desirable, the phalanges of the toes in their entire length, or the phalangeal joints, could be resected in precisely the same manner as those of the fingers; but there is little to be gained by practising these operations on the dead body, as circumstances rarely, if ever, arise necessitating their performance on the living.

Resection of the metatarsal bone of the great toe.—A slightly-curved incision should be made, commencing on the inside of the first joint of the great toe, running along the back of the metatarsal bone, and terminating on the inside of the articulation between that bone and the internal cuneiform. The soft parts being dissected from the back of the bone so as to clear its shaft, this should be grasped with the lion forceps and its ligamentous connections with the tarsus first divided; the bone being raised, the knife is to be passed beneath it, and the plantar connections of its shaft divided; and lastly, its articulation with the first phalanx being destroyed, the operation will be complete.

Resection of the ankle-joint.—The conditions that demand resection of this articulation on the living body would produce such alterations, either in the soft parts about or in the mutual relation of its bones to each other, that an operation performed on the dead body could bear but little resemblance to that required on the living. Happily, in the majority of cases where the operation is required during life, the articular extremities of the bones of the leg are already dislocated, and only need to be sawn off to allow of their replacement. For those who may wish to perform the operation on the dead subject, we will describe a pro-

ceeding by which it can be accomplished, and which, in certain cases of gunshot wounds of the articulation, might be usefully employed on the living.

The operator standing on the inner side of the leg*, should commence an incision on the posterior border of the fibula, two inches above the extremity of the outer malleolus; this cut must be carried down the bone to its extremity, and, crossing the front of the ankle-joint, should pass behind the inner malleolus to the same extent up the posterior border of the tibia; the flap thus traced out must be reflected, taking care that the subjacent tendons are not injured. The peronei muscles should now be turned out of their groove; and the extremity of the fibula being cleared, the director should be passed behind it and the bone sawn through. The lower end should now be grasped with the lion forceps, while with the scalpel its ligamentous connections are divided, when it may be removed. The operator should now attack the lower end of the tibia in the same manner; and having divided its ligaments, the foot may be dislocated outwards, and the articular extremity of the bone sawn off. This proceeding saves the neighbouring tendons and vessels, but is extremely difficult of execution, even on the dead body.

Resection of the knee-joint.—The operator, standing on the right-hand side of the limb—*i. e.* outside the right knee and inside the left—should trace out with a scalpel a semi-lunar flap, commencing opposite the posterior part of the condyle most distant from himself, crossing the front of the joint below the patella, and terminating over the upper part of the other condyle of the femur. This flap, consisting of integuments alone, should be dissected up from the front of the joint, which latter must now be fully opened; the assistant at the same time strongly flexing the

* This description applies to the left leg.

limb. As he does so, the operator should sever all remaining ligamentous connections between the bones, being especially careful during the division of the posterior ligament. He should now pass the knife around the lower end of the femur, just at that part where he wishes to apply the saw ; with this he may remove a portion of the bone, cutting from its anterior towards its posterior surface, and taking care that the section be at right angles to the long axis of the shaft. Any connection that this portion of bone may still retain after the application of the saw should be divided carefully with the scalpel. A thin shell of bone being removed in the same manner and with the same precautions from the extremity of the tibia, the operation will be complete. The patella is generally removed with the portion of the femur that is taken away. No blood-vessels of any consequence should be divided.

Resection of the hip-joint. — The operation which passes by this name consists in the removal of the head of the femur: it may be well to practise it on the dead body, though on the living, the head of the bone is in most cases dislocated by disease previous to being subject to operation ; the ordinary instruments for resection are sufficient for this proceeding.

The body being turned over towards the opposite side, and the thigh slightly flexed, the operator should place himself by the side of the joint he is about to excise, and make a curved incision on the outer side of the joint, embracing in its concavity and passing close behind, the most prominent part of the great trochanter. This incision should be from four to five inches in length, and should commence between the anterior superior spine of the ilium and the top of the trochanter major. The glutei muscles being divided, and the external rotator muscles, the capsule may be opened from behind, while the limb is forcibly flexed and adducted by an assistant; this will

being the ligamentum teres within reach, which when cut, will allow of the dislocation of the head of the bone. The director being passed around its neck, the head may be removed with the saw, and the operation will be complete.

There are various methods of dividing the soft parts over this joint; but whatever plan be pursued, it must be put in practice over the posterior and outer part of the articulation, and the incision, of whatever form, should fall between the trochanter and the great sciatic nerve.

CHAP. IX.

ON THE USE OF CERTAIN INSTRUMENTS.

Application of the Trephine to the Skull.—To long Bones.—Operation for the Removal of a Sequestrum.—The Stomach-pump.

THE trephine, besides its more obvious purpose for removing portions of the bones of the vault of the skull, is used for exploring the cancellous extremities of long bones, and for exposing the medullary cavity of their shafts.

For trephining the skull a small scalpel, a probe, and an elevator are required in addition to the trephine itself. In applying this instrument to the cranium on the dead body, a precaution should be adopted which cannot always be followed on the living — namely, that of selecting a spot for its application out of the course of the trunk of the middle meningeal artery, and clear of the longitudinal or lateral sinuses; as a general rule, the immediate neighbourhood of the sutures should be avoided. A spot having been selected, the scalp should be cleanly reflected from the bone over the parts, either by a semilunar, crucial, or A-shaped incision; the operator, standing well above the part, should project and fix the central pin of the trephine about a line beyond its serrated edge, and apply the instrument to the bone with an alternating semirotatory movement, until it has cut for itself a groove of sufficient depth to obviate the chance of slipping aside: the pin may be now removed and the rotatory movement of the instrument continued until the diploe is reached; this may be ascertained by the



more easy movement of the trephine, and the grating sensation communicated to the hand. The elevator may now be used to raise and remove the outer table of the bone: to the deeper part the trephine should be employed more carefully until the inner table is nearly cut through; when, from time to time, the flat end of a probe or a pointed piece of quill may be introduced into the groove, to ascertain if the dura mater be exposed at any spot. Owing to the spheroidal form of the skull, this is almost sure to take place at one part of the circumference of the groove before another, as it is impossible to make the instrument cut to an equal depth in its whole circumference; if the bone is ascertained to be perforated at one spot, the trephine should be inclined towards the opposite side, until the included portion be almost wholly separated, when its complete removal can be effected by using the elevator.

Cancellous extremities of bones. — In exploring these with the trephine, the soft parts over the bone having been reflected, the instrument may be applied in the same manner as described above, though less caution is required; and the trephine must occasionally be removed to clear it from the portions of bone which it separates and which clog its serrated edge.

The cancellous ends of bones may also be advantageously explored by means of the gouge; and this is particularly useful when it is advisable that the perforation in the bone should be of small size, though extending deeply into its substance. The gouge should be used in the same manner as an ordinary gimlet, being screwed round and round, while pressure is made against its handle with the palm of the hand.

One of the readiest methods of removing a portion of the shaft of a bone, such as the tibia, so as to expose its

medullary cavity, is to make use of the trephine, in conjunction with Hey's saw, in the following manner.

Operation for removal of a sequestrum from the interior of the shaft of a bone.—To effect this it is generally necessary to remove a portion of the shaft wall of the bone. The most subcutaneous part of this being exposed by an incision shaped *, the trephine should be applied at either end of the piece of bone to be removed, the crown of the instrument being of the same diameter as the portion of bone; two circular pieces having been thus removed so as to open the medullary cavity, a Hey's saw should be used to connect the opposite and external margins of these holes in the bone, and the elevator applied to the portion of the shaft thus circumscribed: in this way a piece of the shaft wall may be removed of sufficient size to expose the medullary cavity, and to allow of the extraction of a sequestrum; the portion removed will be  shaped. Again, the interior of the shaft of a long bone may be exposed by making, with Hey's saw, two longitudinal incisions parallel with the long axis of the bone, and connecting their extremities at either end by dividing the intervening bone with a chisel and mallet, and thus removing an oblong portion of the shaft wall.

The stomach-pump.—This instrument, for introducing or withdrawing fluids from the cavity of the stomach, should always be examined before being used, to ascertain its mode of action; all are not precisely alike in the arrangement of their valves: it is therefore advisable, first to plunge the extremity of the instrument into a basin of water, and to work the piston up and down once or twice.

* The long limb of this incision should be parallel with the long axis of the bone.

The operator, being provided with an œsophageal tube, which must fit the nozzle of the pump, should stand on the right-hand side of the body, the head of the latter being slightly thrown back. Having oiled the extremity of the tube *, he should place the forefinger of the left hand into the right-hand angle of the mouth, and depress the tongue, while with the right hand he should introduce the tube at the opposite corner of the mouth, pass it straight back to the posterior wall of the pharynx, and turning the point downwards, should push it on until, by the length of tube that has disappeared, it cannot but have entered the stomach. The end of the tube should now be attached to the pump, and the extremity of the latter plunged into water: about a pint having been thrown into the stomach, the valve may be reversed, and some of it withdrawn, and this proceeding repeated at the discretion of the operator. On the living body the reverse action of the instrument — we mean the drawing of the fluid out of the stomach — is seldom needed; it is generally sufficient to shake the tube in the throat, or to pull it up and down a little. This will for the most part produce the speedy complete evacuation of the contents of the stomach by vomiting.

* It may be advantageously bent to a small extent, so as to give it a very gentle curve.

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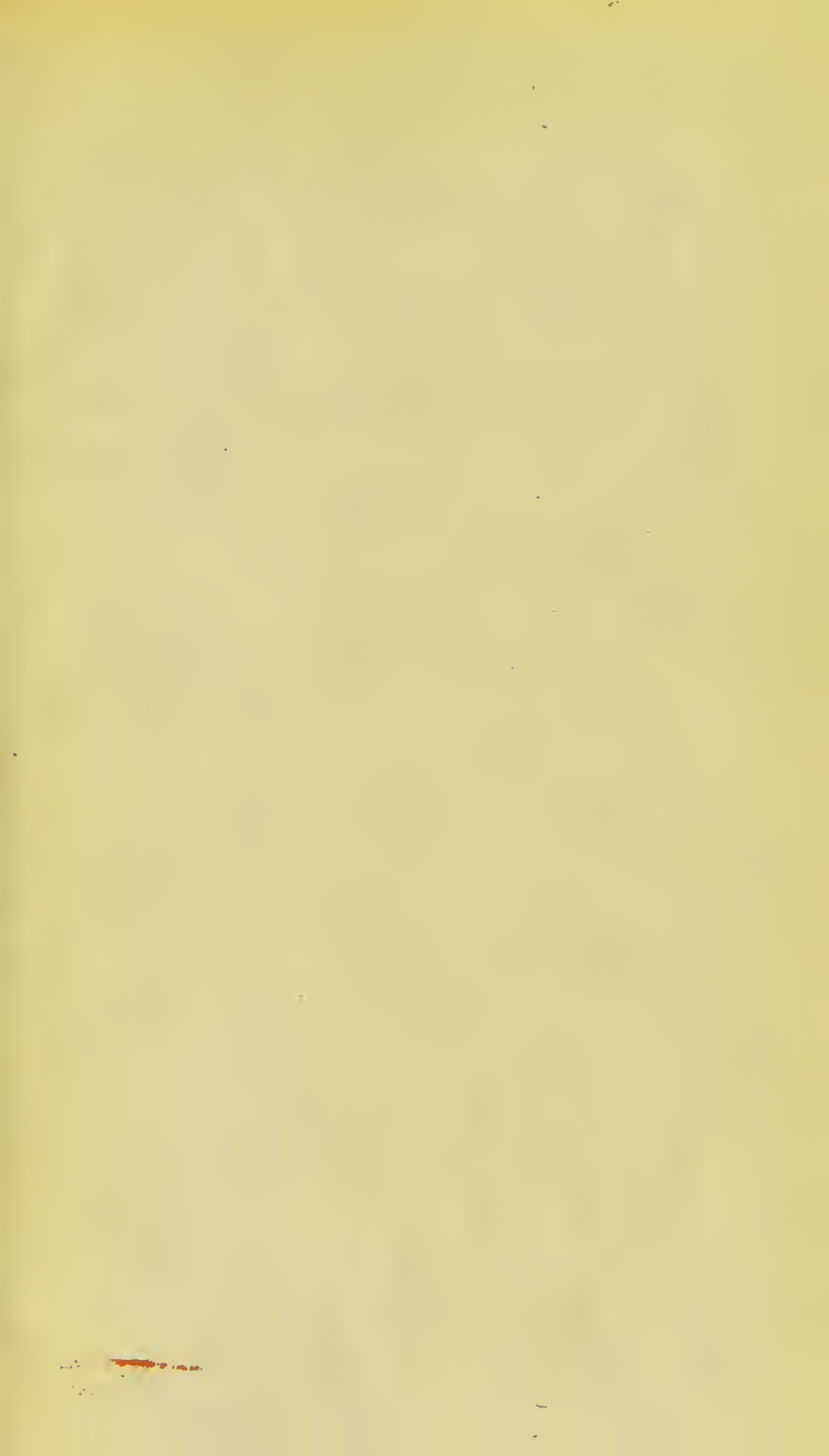
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